TM 11-2004

WAR DEPARTMENT TECHNICAL MANUAL

REPEATER SET TC-18

(TERMINAL, TELEGRAPH)

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WAR DEPARTMENT *JUNE 1945*

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This manual supersedes TM 11-2004, 12 August 1943, and TB 11-2004-1, 18 July 1944.

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WAR DEPARTMENT

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TM 11–2004, Repeater Set TC–18 (Terminal, Telegraph), is published for the information and guidance of all concerned.

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Refer to FM 21–6 for explanation of distribution formula.

CONTENTS

		Paragraph	Page
PART ONE.	INTRODUCTION.		
Section I.	Description of Repeater Set TC–18 (Terminal, Telegraph).		
	General	1	1
	Table of components for Repeater Set TC–18	2	2
	Description of Repeater TG–30 (Terminal, Telegraph)	3	2
	Description of Ground Rod MX–148/G	4	4
	General functioning of Repeater TG–30	5	4
	Electrical characteristics of Repeater TG–30	6	7
II.	Application of Repeater TG–30 (Terminal, Telegraph).		
	General	7	8
	Line operation	8	8
	Local operation	9	9
	Two Repeaters TG–30 used for intermediate operation	10	10
	Use of Regenerative Repeater OA–3/FC with Repeater TG–30	11	10
	System operating ranges	12	11
III.	Unpacking, setting-up, and repacking instructions.		
	Location of equipment	13	12
	Uncrating, unpacking, and checking	14	12
	Repacking instructions	15	13
PART TWO.	OPERATING INSTRUCTIONS.		
Section IV.	Equipment connections and initial adjustments.		
	General	16	14
	Grounding arrangements	17	14
	Connections to the line	18	14
	Connections to local equipment	19	15
	Line switch positions	20	16
	Local switch positions	21	17
	Power supply arrangements	22	18
	Equipment checks	23	19
V.	System line-up.		
	General	24	19
	Line current adjustments	25	19
	Local current adjustments	26	20
VI.	Summary of procedure for placing equipment in service.		
	Line-up procedure	27	20
VII.	Routine checks of performance.		
	Records	28	22
	Purpose and use of check list	29	22
	Equipment performance check list for Repeater TG–30 (Terminal, Telegraph)	30	24
PART THREE.	PREVENTIVE MAINTENANCE.		
Section VIII.	Preventive maintenance techniques.		
	Meaning of preventive maintenance	31	25
	Description of preventive maintenance techniques	32	25
	Repeater TG–30, exterior	33	26
	Power cord	34	26
	Fuses	35	26
	Headset	36	26
	Ground rods	37	27
	Relays	38	27
	Meter	39	27
	Binding posts	40	28
	Protectors	41	28
	Telegraph key	42	28
	Wiring	43	28
	Keys and switches	44	28
	Potentiometers	45	28
	Terminal blocks	46	29
	Jacks	47	29

		Paragraph	Page
	Plug	48	29
	Capacitors	49	30
	Resistors	50	30
	Transformers and filters	51	30
	Preventive maintenance tools and materials	52	30
IX.	Preventive maintenance check list.		
	Preventive maintenance check list	53	31
	Preventive maintenance check list for Repeater Set TC–18	54	31
X.	Lubrication.		
XI.	Moistureproofing and fungiproofing.		
	General	55	32
	Treatment	56	32
	Repeater TG–30 (Terminal, Telegraph)	57	32
	Moistureproofing and fungiproofing after repairs	58	34
PART FOUR.	AUXILIARY EQUIPMENT (NOT USED).		
PART FIVE.	REPAIR INSTRUCTIONS.		
Section XII.	General repair procedure.		
	Repair techniques	59	36
	Unsatisfactory equipment report	60	36
XIII.	Detailed functioning of Repeater TG–30 line circuits.		
	Theory of operation	61	38
	General line circuit arrangements	62	39
	Adjust line current circuit	63	40
	Line side of repeater operating polarential	64	40
	Line side of repeater operating two-path polar	65	42
XIV.	Detailed functioning of Repeater TG–30 with local equipment circuits.		
	General	66	43
	Local operation with Teletypewriter TG–7–B	67	43
	Local operation with Switchboard BD–100	68	44
	Local operation with Line Unit BE–77–(*)	69	45
	Local operation with a teletypewriter equipped with a line relay	70	46
	Local operation with a carrier telegraph terminal	71	47
	Local operation using two Repeaters TG–30 to provide intermediate operation	72	48
	Manual telegraph set operation	73	48
	Rectifier power circuit operation	74	50
XV.	Trouble location.		
	General trouble-locating information	75	50
	Test equipment	76	51
	Trouble-locating procedures	77	52
	Operator's trouble-locating chart	78	53
	Trouble location with repeater out of service	79	53
	Repairman's trouble-locating chart	80	54
	Point-to-point voltage and resistance measurement chart	81	55
XVI.	Repairs.		
	Disassembly for repairs	82	60
	Replacement of parts	83	60
	Restoration of electrolytic capacitors	84	60
	Painting and refinishing	85	60
APPENDIX I.	LIST OF COMPONENT PARTS OF REPEATER TG–30		63
II.	MAINTENANCE PARTS FOR REPEATER SET TC–18		64
III.	REFERENCES		65

WARNING

If necessary to remove the repeater from the carrying case, disconnect power cord from the power source.

Avoid touching terminals with bare hands while testing. All test leads should be insulated.

DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN — When ordered by your commander.

HOW — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT — 1. Smash — Carrying case cover, panels, telegraph key, meter, switches, jacks, relays, resistors, capacitors, headset, and framework.

2. Cut — Transformer coil windings, relay windings, all wiring and cables.

3. Burn — Carrying case, manuals in canvas pocket.

4. Bend — Frameworks and panels.

5. Bury or scatter — Any or all of the above pieces after destroying their usefulness.

DESTROY EVERYTHING

This manual supersedes TM 11–2004, 12 August 1943, and TB 11–2004–1, 18 July 1944.

PART ONE
INTRODUCTION

Section I. DESCRIPTION OF REPEATER SET TC–18 (TERMINAL, TELEGRAPH)

1. General

a. Repeater Set TC–18 (Terminal, Telegraph) is a portable d-c telegraph repeater set consisting of two Ground Rods MX–148/G and one Repeater TG–30 (Terminal, Telegraph). Repeater TG–30 (Terminal, Telegraph) is a d-c telegraph terminal repeater designed for transmitting to and receiving

Figure 1. Repeater TG–30 (Terminal, Telegraph) in use.

from another Repeater TG–30 (Terminal, Telegraph), or its equivalent, at a distant terminal on a half-duplex basis, either with or without Repeater TG–31 (Intermediate, Telegraph), at *one* intermediate point. Two Repeaters TG–30 may be connected together to provide an intermediate repeater.

b. Repeater TG–30 is designed for operation on field-wire line circuits (simplexed), spiral-four cable circuits (simplexed), and open wire circuits (composited) with ground return.

c. The repeater is arranged for local operation with a teletypewriter, or 30-milliampere or 60-milliampere neutral (open and closed) local circuits. A manual telegraph set integral with the repeater equipment is used when teletypewriter equipment is not available.

d. A source of 115-volt or 230-volt, 50- to 60-cycle alternating current, or 115 volts dc is required to operate the equipment. When dc is used it must be from a nongrounded source.

2. Table of Components for Repeater Set TC–18

The items listed below are the components of Repeater Set TC–18 (Terminal, Telegraph). See paragraph 86, appendix I, and Signal Corps catalog for a list of component parts for Repeater TG–30. The data given below are for the equipment unpacked and ready for use.

Quan	Component	Weight (lb)	Dimensions	Volume (cu ft)
1	Repeater TG–30 (Terminal, Telegraph) (package 1)	130	2′ 1″ x 1′ 4″ x 1′ 2½″	3.5
2	Ground Rod MX–148/G (package 2)	9.5 (ea)	6′ x ¾″ (diam)	—

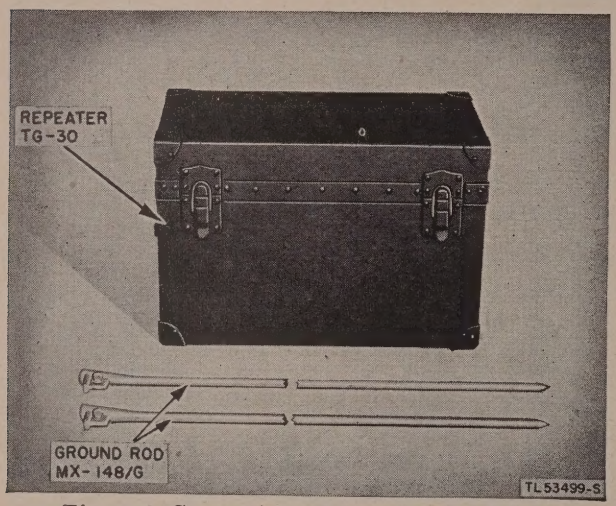


Figure 2. Components of Repeater Set TC–18 (Terminal, Telegraph).

3. Description of Repeater TG–30 (Terminal, Telegraph)

a. The repeater is housed in a durable wooden carrying case (fig. 3) which completely incloses all equipment while in transit. A carrying handle is provided on each end of the case. The apparatus comprising the repeater is supported on mounting plates and panels attached to a framework which is supported on shockproof mountings. The complete assembly may be easily removed from the carrying case and mounted on a 19-inch relay rack. The equipment is constructed for use over a wide temperature range and for use under tropical conditions.

b. The repeater with the carrying case open for service is shown in figure 4. Binding posts for making connections, jacks, switches, potentiometers, fuses (with spares), and a meter used for measuring d-c repeater voltage and line current are conveniently assembled and clearly designated on the face of the equipment. (See fig. 5.) The repeater equipment is furnished with a receptacle and jacks for connecting the teletypewriter (power and transmission cords), a jack for connecting the headset used with manual telegraph operation, and a jack which can be used to supply power to a relay test set such as Test Set I–193–A. The manual telegraph key, used for manual telegraph operation, is also mounted on the face of the equipment.

c. Storage space is located inside the cover of the carrying case for additional spare fuses and spare neon lamps (used in the manual telegraph set circuit). Line protectors and spares are located inside the repeater unit. The headset, with its associated cord and plug, is held in a clamp on the side of the unit when not in use.

d. A summary of operating instructions, which is condensed from the instructions given in this manual, is mounted inside the repeater cover. A circuit label diagram (fig. 59) is

mounted in the bottom of the repeater case. Technical manuals are contained in a canvas pocket which is attached to the carrying case. The canvas pocket is folded over the repeater unit when the cover is closed, and hangs over the front of the carrying case when the repeater is in operation.

Note. On earlier models the canvas pocket for the technical manuals was located on the inside of the cover of the carrying case.

Figure 3. Repeater TG–30 (Terminal, Telegraph), ready for transit.

4. Description of Ground Rod MX–148/G

The ground rod is a galvanized steel rod, 6 feet in length and ¾ inch in diameter. It has a shaped head to facilitate driving and to protect the wingnut wire connecting device during transportation and driving.

Note. On earlier shipments of Repeater Set TC–18, Ground Rod GP–29 was shipped instead of Ground Rod MX–148/G.

5. General Functioning of Repeater TG–30

a. Binding Posts and Line and Local Switches. The line and local circuit features required for the different forms of service possible with Repeater TG–30 are obtained by turning a LINE switch and a LOCAL switch to specific positions and by connecting wires to specific LINE and LOCAL binding posts. (See

Figure 4. Repeater TG–30 (Terminal, Telegraph), carrying case open for service.

fig. 5.) A combination of the LINE switch position and the LINE binding post connections provides the required line circuit arrangements, and a combination of the LOCAL switch and LOCAL binding post connections provides the local circuit arrangement. (See figs. 6 and 7.) The line and local switches are multiple contact switches. The line switch is a 3-position switch and the local switch is a 5-position switch. No switching relays are used. Two LINE binding posts, one GND binding post, and three LOCAL binding posts are needed. When Teletypewriter TG–7–B, Printer TG–7–A, Teletypewriter TG–37–B, Reperforator Transmitter TG–26–A, or Reperforator Transmitter TG–27–A is used for local equipment the transmission cords are plugged into the PRINTER send and receive jacks.

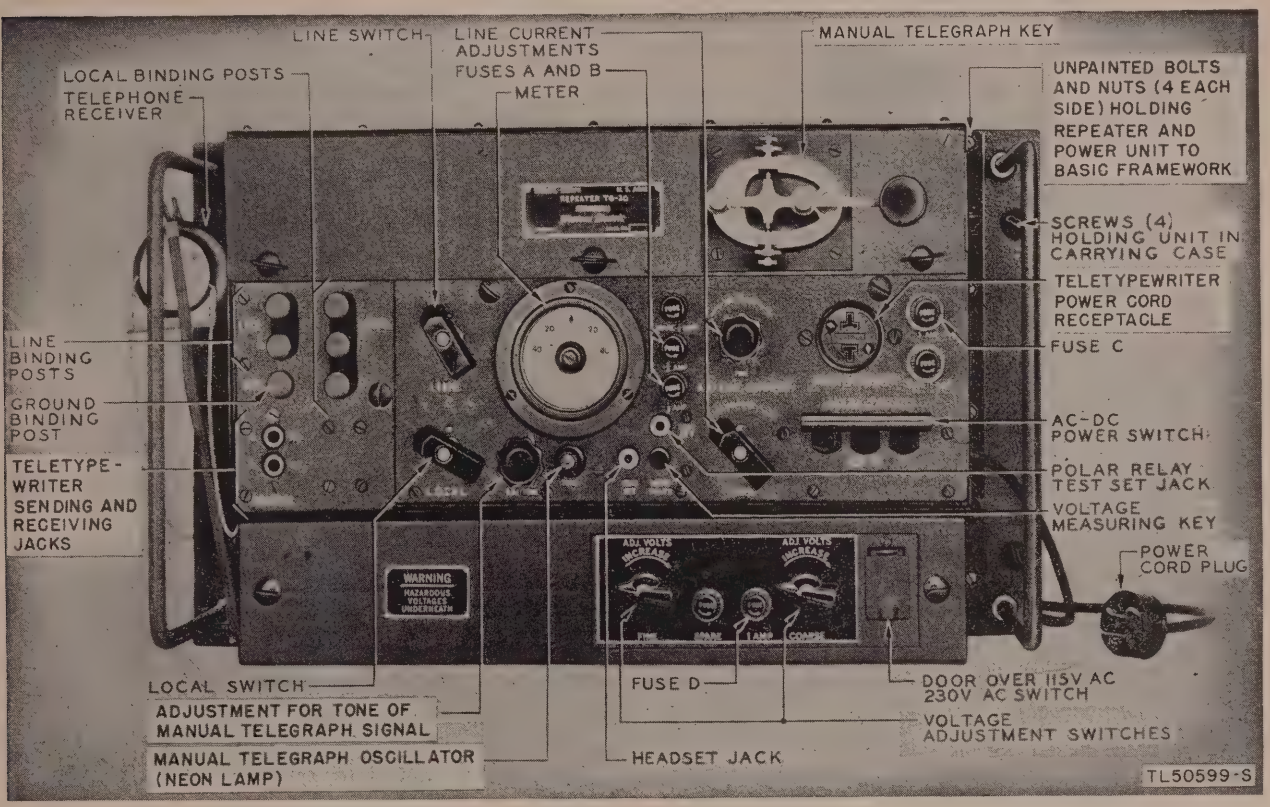


Figure 5. Repeater TG–30 (Terminal, Telegraph), removed from carrying case, top view.

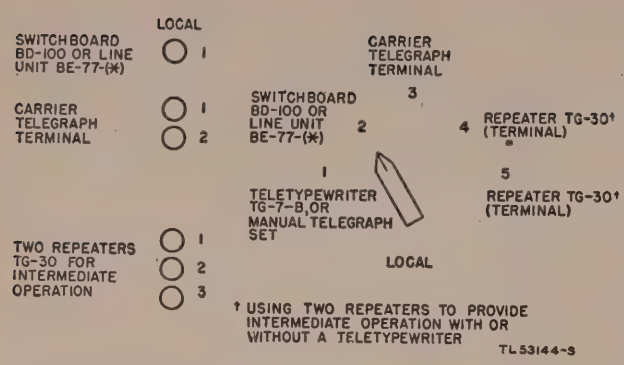


Figure 6. Functions of local binding posts and local switch.

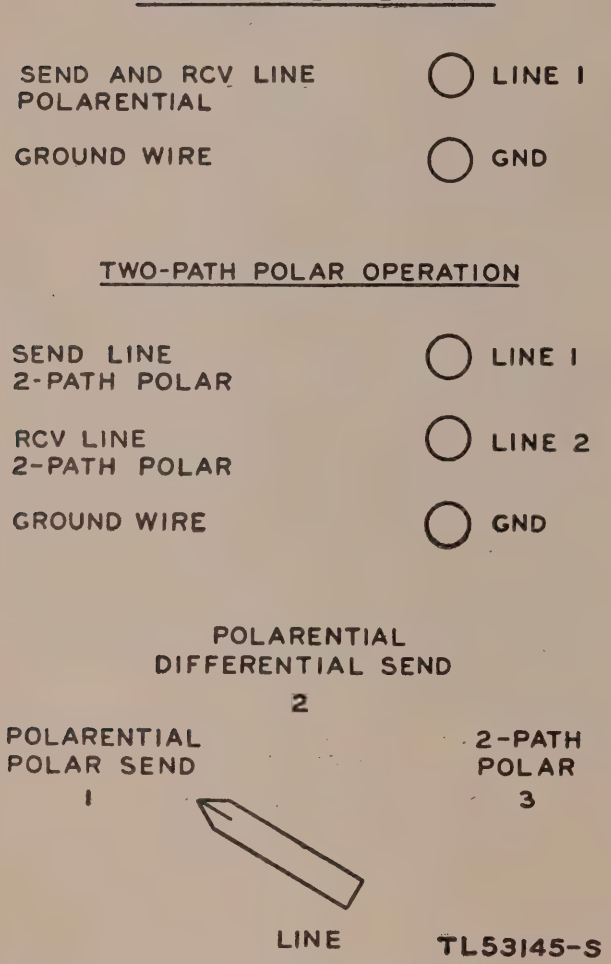


Figure 7. Functions of line binding posts and line switch.

b. LINE CURRENT ADJUSTING CONTROLS AND METER. The line current is adjustable at a repeater set up for polarential polar sending (LINE switch in position 1), and, if it is set up for two-path polar (LINE switch in position 3), it is adjustable in the sending line at the repeater. An approximate adjustment of line current can be obtained with the ADJ LINE CURRENT knob COARSE. The required line current is then obtained with the ADJ LINE CURRENT knob FINE. The line current in milliamperes is read on the meter.

c. POWER SUPPLY. The repeater can be arranged for operation on alternating current or direct current. The various controls and switches for the power supply are described below.

(1) *AC-DC Power Switch.* The AC-DC power switch is used to arrange the repeater for operation on alternating current or direct current. When operated to 115V OR 230V AC the repeater is arranged for operation on alternating current. When operated to 115V DC the repeater is arranged for operation on direct current.

(2) *115V AC—230V AC Switch.* The 115V AC–230V AC switch is used to arrange the repeater for operation on 115 volts ac or 230 volts ac.

(3) *MEAS VOLTS Key.* The MEAS VOLTS key is arranged to connect the meter to the output of the repeater rectifier. When the key is held down the d-c voltage output of the rectifier is read, or, if the main power supply is direct current, the voltage of the power supply is read.

(4) *ADJ VOLTS Switches.* The ADJ VOLTS switches are used to obtain the required output of 115 volts dc when the main power supply is ac. The ADJ VOLTS switch designated COARSE is used to obtain an approximate value of voltage, and the ADJ VOLTS switch designated FINE is used to obtain the required 115 volts dc.

(5) *PRINTER POWER Receptacle.* The PRINTER POWER receptacle is furnished so that the power cord from the teletypewriter may be plugged in and power furnished to the teletypewriter motor.

d. Manual Telegraph Set. A manual telegraph set is built in to provide a means of communication when teletypewriter equipment is not available or cannot be operated. The component parts of this set consist of a small neon lamp (TONE) connected in an oscillator circuit, a telegraph key, and a 1,000-ohm telephone receiver (headset). The headset is supplied with a cord and plug for connecting to a HEADSET jack in the repeater. The neon lamp and the telegraph key are normally con-

nected to the repeater and are available for service when the headset is connected. The frequency of the oscillator (neon lamp) is adjustable by means of a potentiometer (ADJ TONE) with a knob conveniently located on the operating panel. The frequency of the oscillator, that is, the tone heard in the receiver, may be regulated to suit using personnel. A tone in the order of 1,000 cycles should generally be satisfactory. The manual telegraph set is inoperative when a teletypewriter is connected.

e. TEST SET JACK. The TEST SET jack is arranged so that d-c power may be furnished to Test Set I–193–A.

6. Electrical Characteristics of Repeater TG–30

a. GENERAL. Repeater TG–30 is a d-c telegraph terminal repeater. It receives d-c signals over a neutral type circuit from the local equipment and repeats these d-c signals to a polarential or two-path polar line. At the distant terminal the d-c signals from the line are repeated to the local equipment over a neutral type circuit. The repeater may be used on 60-speed (368 operations per minute) or 66-speed (404 operations per minute) teletypewriter circuits. A communication break feature is incorporated in the repeater design.

b. LINE OPERATION. The line side of the repeater is arranged for either polarential operation or two-path polar operation. Only one telegraph circuit is required for polarential operation, while two telegraph circuits are required for two-path polar operation.

c. LINE PROTECTION. Carbon block line protectors prevent damage of the equipment in case of line voltage surges. One pair of protector blocks is connected to each line binding post of the repeater. These blocks have an air gap of about .005 inch.

d. NOISE INFLUENCE ON TELEPHONE CIRCUITS. Repeater TG–30 is furnished with a retardation coil in series in the line circuit to serve as a noise killer to prevent undesirable noise on simplexed telephone circuits. In addition, a noise filter is required on composited circuits to maintain the same noise level standard as on simplexed circuits. This noise filter should be provided with the composite equipment.

e. RADIO INDUCTION SUPPRESSION. The wiring to the line and local binding posts and to the PRINTER send and receive jacks is carried through filters, and the power cord and wiring to the PRINTER POWER receptacle is supplied with power-lead filters to reduce interference to nearby radio receiving equipment. These filters contain low-resistance air-core coils and small bypass capacitors. The filters are effective in a range from about 200 kilocycles to 18,000 kilocycles.

f. TELEGRAPH POLAR RELAYS (figs. 8 and 9). (1) The repeater uses three polar relays of the same type. Each relay has three windings and is arranged for mounting in a vacuum tube socket which serves as a connecting block. One winding is a 90-ohm winding and the other two are 1,450-ohm windings. Figure 51 shows the winding and terminal arrangements of the relay. The relay is tested and adjusted by use of Test Set I–193–A.

(2) Each polar relay should contain two gas adsorber units. The adsorber units are small metal wire cloth bags, each containing 2 grams of activated charcoal. The gas adsorber units prevent excessive contact corrosion by adsorbing any hydrocarbon vapors which may be present within the relay case. These vapors emanate from various materials such as moistureproofing and fungiproofing lacquers, paints, and phenolics used in component parts of the equipment.

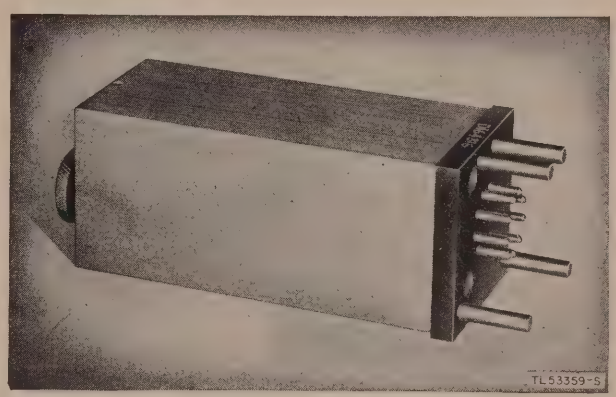


Figure 8. Polar relay, cover in place.

g. POWER SUPPLY. The repeater contains a built-in-rectifier power unit. The repeater circuits require ungrounded 115 volts dc. The primary power source operating the equipment may be alternating current (commercial or gasoline-engine-driven generator) or direct current (gasoline-engine-driven generator). The repeater may be operated on 95 to 125 volts, 50 to 60 cycles ac; 190 to 250 volts, 50

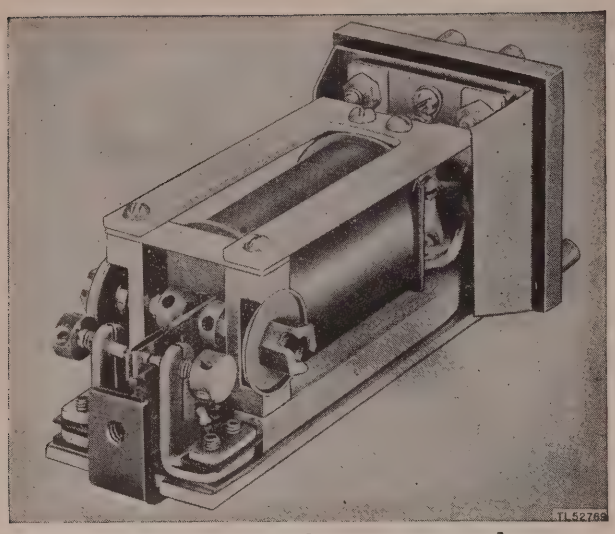


Figure 9. Polar relay, cover removed.

to 60 cycles ac; or 115 volts dc. A selenium disk type rectifier is used to convert a-c power to d-c power. A 10-foot flexible cord is attached to the repeater for connecting to the power supplies. The full load output rating of the rectifier is 400 milliamperes at 115 volts. The output voltage is sufficiently constant for operation of the repeater under normal load variations. It is not equipped with automatic regulation. When the equipment is operated from an a-c supply, approximately 80 watts of power is required for the rectifier. An additional 120 watts is required when a teletypewriter is used, making a total of 200 watts. When a d-c supply is used, the repeater circuit will require approximately 50 watts and the teletypewriter 90 watts, making a total of 140 watts. When operation is from 115 volts dc, the supply (Power Unit PE–77–D, or equivalent) must be *nongrounded* and the voltage *regulated externally* because no d-c power adjustment is furnished with the repeater.

Section II. APPLICATION OF REPEATER TG–30 (TERMINAL, TELEGRAPH)

7. General

Repeater TG–30 is designed for a number of different applications with respect to both line and local operation. It may be operated on all types of line conductors. The various types of operation and operating distances for some of the more common types of line conductors are covered in the following paragraphs.

8. Line Operation

a. TERMINAL TO TERMINAL. Figure 10 is a general schematic showing a typical system application of Repeater TG–30. The system is comprised of two repeaters with local teletypewriter equipment on each end of the system. Two types of line operation are possible with this system.

(1) *Polarential.* This type of operation requires only one telegraph circuit. One terminal, usually designated terminal A, is arranged as the polar-sending end of the system, and terminal B, at the other end of the line, is arranged as the differential-sending end of system.

(2) *Two-path Polar.* This type of operation requires two telegraph circuits. One circuit is used for transmission in one direction and the other is used for transmission in the opposite direction.

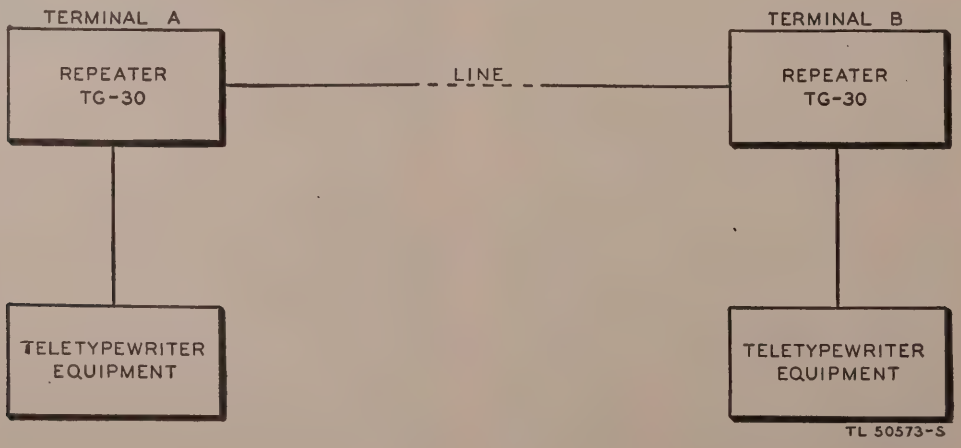


Figure 10. Typical system application of Repeater TG–30, line operation, terminal to terminal.

b. TERMINAL TO TERMINAL WITH REPEATER TG–31 (INTERMEDIATE, TELEGRAPH). Figure 11 is a general schematic of a system comprised of two Repeaters TG–30 and one Repeater TG–31. The operating distance of the system is extended (table I) by using the intermediate repeater. However, only one Repeater TG–31 can be used in the line circuit between two terminal repeaters. Operation with Repeater TG–31 requires that both terminal repeaters be arranged as polar-sending terminals.

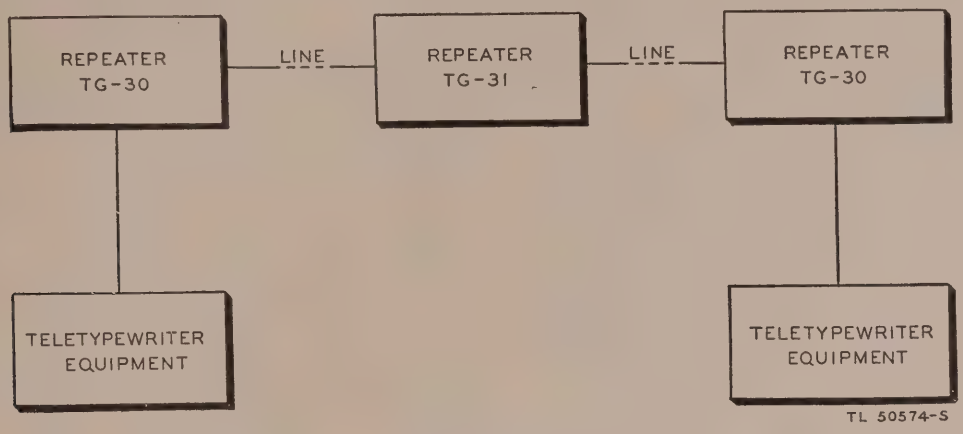


Figure 11. Line operation, terminal to terminal with Repeater TG–31 (Intermediate, Telegraph).

c. OTHER TYPES OF LINE OPERATION. Figures 12 and 13 show other types of equipment which may be used for line operation with Repeater TG–30.

(1) *Telegraph Repeater OA–6/FC.* This type of line operation is of the same type as was covered in *a* above, with Telegraph Repeater OA–6/FC (d-c telegraph repeater packaged equipment X–61824A) taking the place of Repeater TG–30 at the other end of the line.

(2) *Carrier Telegraph Terminal.* In this manual the term carrier telegraph terminal is used to indicate the following equipment:

Telegraph Terminal CF–2–A (Carrier)
Telegraph Terminal CF–2–B (Carrier)
Telegraph Terminal CF–6 (Carrier)
Carrier Terminal OA–4/FC (V-f carrier telegraph packaged equipment X–61822A)
Carrier Terminal OA–5/FC (V-f carrier telegraph packaged equipment X–61822B).
Telegraph Terminal TH–1/TCC–1

Figure 12 shows operation on a half-duplex basis. Figure 13 shows full-duplex operation. For full-duplex operation, two Repeaters TG–30 are required, also two teletypewriters, one connected to each repeater on its local side. One teletypewriter serves as a receiving-only machine and the other as a sending teletypewriter which also produces local copy.

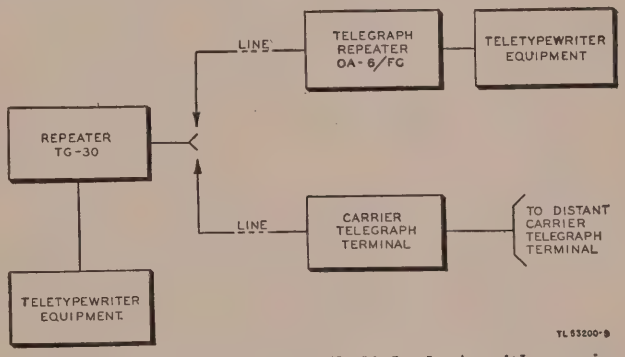


Figure 12. Line operation (half-duplex) with carrier telegraph terminal, or Telegraph Repeater OA–6/FC.

9. Local Operation

a. Figures 14 and 15 are general schematics showing equipment which may be used for local operation with Repeater TG–30. With the exception of the manual telegraph set, which must operate to the manual telegraph set at a distant Repeater TG–30, any of the local equipment shown may be connected at the distant end of the system. Operation between Repeater TG–30 and the local equipment is over a neutral type circuit.

b. When Teletypewriter TG–7–B is used for local operation the power and transmission cords are connected directly to Repeater TG–30. See paragraph 5*a* for other types of teletypewriter equipment which may be used in place of Teletypewriter TG–7–B. A teletype-

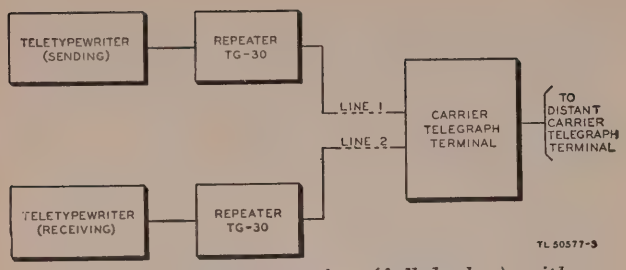


Figure 13. Line operation (full-duplex) with carrier telegraph terminal.

writer equipped with a line relay may be located some distance from Repeater TG–30. (See table II.)

c. Local operation with Switchboard BD–100 or Line Unit BE–77–(*) is similar to operation with a teletypewriter equipped with a line relay. Local operation with a carrier telegraph terminal is used when Repeater TG–30 is connected to another Repeater TG–30 at the distant end of the line, with or without Repeater TG–31. Greater operating distance may be obtained by using this type of operation rather than the type discussed in paragraph 8*c*(2). (See table I.)

Note. In this manual, Line Unit BE–77–(*) is used to indicate Line Unit BE–77, Line Unit BE–77–A, and Line Unit BE–77–B.

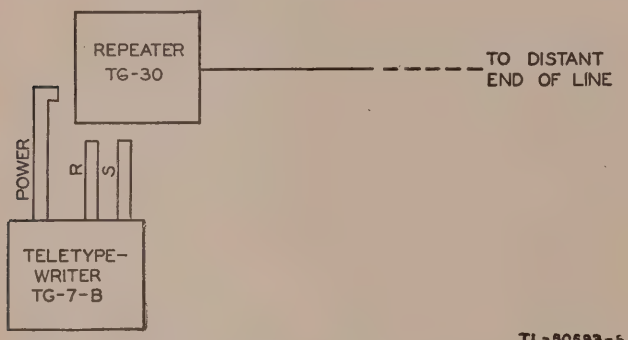


Figure 14. Local operation with Teletypewriter TG–7–B.

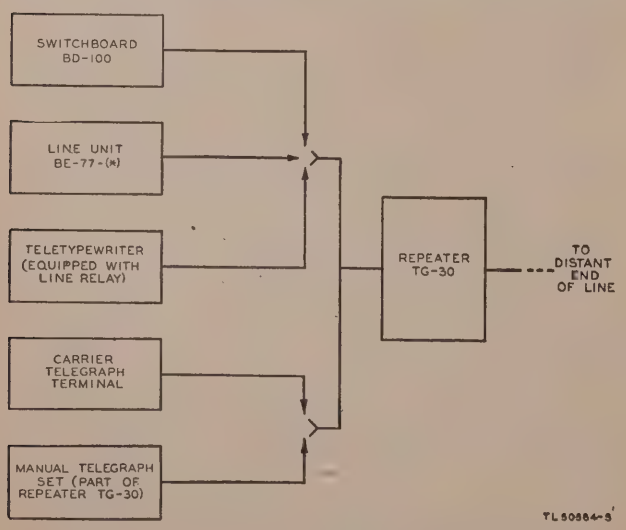


Figure 15. Local operation with other equipment.

10. Two Repeaters TG–30 Used for Intermediate Operation

Figure 16 is a general schematic of a system comprised of four Repeaters TG–30. The two Repeaters TG–30 at the intermediate point are used to take the place of one Repeater TG–31 (Intermediate, Telegraph). The distance between the two repeaters at the intermediate point should not exceed about 200 feet. A teletypewriter may be connected to one of the repeaters if desired. The teletypewriter will send simultaneously in both directions, and will receive from either terminal.

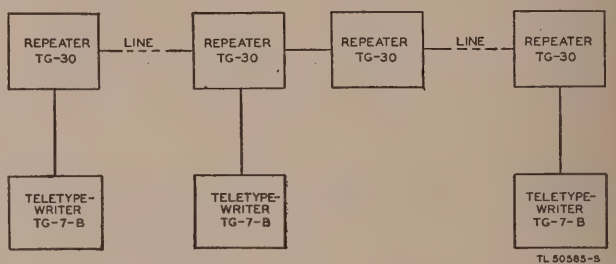


Figure 16. Two Repeaters TG–30 (Terminal, Telegraph) used for intermediate operation.

11. Use of Regenerative Repeater OA–3/FC with Repeater TG–30

The operating distance of a system using Repeaters TG–30 may be extended by using one or more Regenerative Repeaters OA–3/FC (d-c regenerative telegraph repeater packaged equipment X–66031A). The regenerative repeater must be installed before the telegraph signals become sufficiently distorted to cause errors in received copy. Since a regenerative repeater retransmits nearly perfect signals, more than one repeater point can be used. The limit of operation will be reached when errors result in the received local copy. Since Regenerative Repeater OA–3/FC does not contain a power supply, a source of positive and negative 130 volts, regulated to plus and minus 5 volts, must be provided. This source of power should be a low impedance source, such as may be obtained from Western Electric Co power supply unit X–61680B, or its equivalent. The maximum drain on the power supply is during the marking condition and is approximately 120 milliamperes on the negative rectifier and 300 milliam-

peres on the positive rectifier. Figure 17 is a general schematic showing typical operation with Regenerative Repeater OA–3/FC. See paragraph 19*e* and figure 27 for information on connections. See TM 11–2032 for information on Regenerative Repeater OA–3/FC.

(1) Field Wire W–110–B, simplexed.
(2) Field Wire W–143, simplexed.
(3) Spiral-four cable, simplexed.
(4) 104 copper, open-wire line, composited.
(5) 080 copper-steel (40 percent), open-wire line, composited.

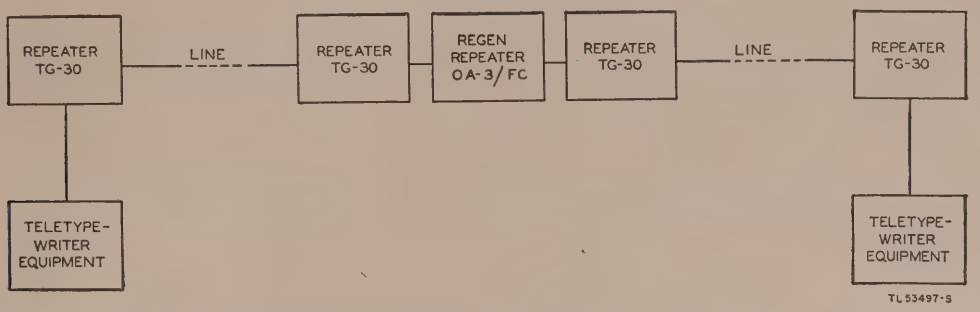


Figure 17. Use of Regenerative Repeater OA–3/FC with Repeater TG–30 (Terminal, Telegraph).

12. System Operating Ranges

a. GENERAL. The operating distances that may be obtained with systems using Repeater TG–30 will be determined by the type of equipment with which it is operating and the type of line conductors over which it is operated.

b. LINE CONDUCTORS. The repeater may be operated on all types of line conductors, the more common of which are as follows:

(6) 104 copper-steel (40 percent), open-wire line, composited.

Open-wire circuits may be operated simplex as well as composited.

c. OPERATING RANGES. The operating ranges in table I are provided as a guide in laying out circuits. *Do not use them as the absolute operating ranges under all conditions.* The operating ranges in table II are given as the maximum operating ranges for equipment connected to the local side of Repeater TG–30.

Table I. Guide for determining operating ranges.

(368 operations per minute)

Polarential or 2-path polar operation	W–110–B, simplexed	W–143, simplexed	Spiral-four cable, simplexed (note B)	104 copper composited (note C)	080 copper-steel (40%) composited (note C)	104 copper-steel (40%) composited (note C)
TG–30 to TG–30 single-line section.	50 miles	75 miles	75 miles	200 miles	95 miles	135 miles
TG–30 to Repeater OA–6/FC single-line section.	50 miles	75 miles	75 miles	200 miles	95 miles	135 miles
TG–30 to TG–30 or TG–30 to Repeater OA–6/FC with TG–31. Two-line sections.	40 miles per section. Total 80 miles.	40 miles per section. Total 80 miles.	50 miles per section. Total 100 miles.	200 miles per section. Total 400 miles.	50 miles per section. Total 100 miles.	100 miles per section. Total 200 miles.
TG–30 to carrier telegraph terminal. Single-line section.	25 miles	40 miles	50 miles	note D	note D	note D

Note A. Circuits operating at 404 operations per minute should be reduced in length to retain the same quality of transmission as is obtainable at 368 operations per minute; or, if the above lengths are retained, the quality of transmission will be reduced at 404 operations per minute. Typical operating ranges without reduction of transmission below a bias tolerance of 15 on single-section lines between two Repeaters TG–30 with teletypewriters are:

Type of wire	*368 operations per minute*	*404 operations per minute**
W–110–B	50 miles	40 miles
W–143	75 miles	70 miles
Spiral-four cable	75 miles	70 miles
104 copper	200 miles	200 miles
080 copper-steel (40 percent)	95 miles	95 miles
104 copper-steel (40 percent)	135 miles	135 miles

*With orientation range scale 50 except for W–110–B wire.

Note B. Suitable for one telegraph circuit per cable without d-c signaling circuit. When other pair is used for d-c signaling circuit, operation should be limited to 50 miles in order to prevent errors in teletypewriter copy due to operation of the signaling circuit.

Note C. For maximum lengths of simplexed open wire use 100 miles or *twice* the maximum length for composited wire, whichever is less.

Note D. Field wire lines are assumed for d-c extension facilities from carrier telegraph terminals.

Note E. At 368 opm, not more than two line sections can be operated in tandem without using a regenerative repeater. At 404 opm, a regenerative repeater may be required at each intermediate point.

Table II. Operating ranges for local circuits

Equipment	*Field Wire (simplexed or multiplied pair)*
Teletypewriter TG–7–B, or equivalent.	note A
Switchboard BD–100	4 miles
Line Unit BE–77–(*)	4 miles
Teletypewriter equipped with a line relay	4 miles
Carrier telegraph terminal	200 feet
Two Repeaters TG–30 used for intermediate operation	200 feet

Note A. Teletypewriter is connected directly to Repeater TG–30.

d. REDUCTION OF OPERATING RANGES. The presence of earth potential, power line induction, or ground resistance reduces operating ranges. The distance specified for operation on field wire circuits is based on adverse weather conditions with wire laid on the ground, and with a maximum capacitance-to-ground of about 8/10 microfarad per mile and a maximum leakage of ¼ megohm per mile. The distance estimated for open-wire lines is based on a maximum leakage-to-ground of ¼ megohm per mile and a maximum leakage, between the wires of a pair, of 3½ megohms per mile. In case the leakage resistance between wires of a pair is substantially less than this value, it may not be possible to use the pair for more than one telegraph circuit. Capacitance-to-ground on open-wire lines is not effective in reducing operating ranges as it is very low.

Section III. UNPACKING, SETTING-UP, AND REPACKING INSTRUCTIONS

13. Location of Equipment

a. Before starting any installation, decide upon the general lay-out in view of local conditions. The equipment should be located so as to provide maximum protection for the equipment and operating personnel. When the equipment must be located in tents or temporary buildings, select the site with the least chance of being flooded, and, if boards or planks are available, construct a secure platform to be used as a base for the equipment. Areas which are liable to become extremely dusty should also be avoided. If possible, choose a location near a good source of ground.

b. When several repeaters, or other pieces of equipment, are to be located at a common point, they should be arranged in convenient alignment to prevent confusion in operating and maintaining the equipment.

c. Wiring and cabling between the units, to other equipment, and to power equipment should be carried overhead when possible and should be so arranged that it will not be damaged and will not be a hazard to traffic during normal operation. In special cases it may be advisable to bury the wiring and cables in the ground if no other suitable protection is available.

d. When a power unit is used, it should be located outside the building, tent, or other structure, so that the exhaust fumes will not be hazardous to the operating personnel. The power wiring should be separated from, and run independently of, the transmission wiring between equipments.

14. Uncrating, Unpacking, and Checking

a. The components of Repeater Set TC–18

(Terminal, Telegraph) are packed in two separate cases. Repeater TG–30 is packed in one case, and the two Ground Rods MX–148/G are packed in the other case.

b. Use particular care when unpacking or handling the equipment because it may be damaged easily when not protected by the packing case. In unpacking the equipment, follow the steps outlined below.

(1) Place the packing case as near the operating location as is convenient.

(2) Cut the steel straps.

(3) Remove the nails, using a nail puller, and remove the sides and top of the packing case. *Prying the sides and top off may result in damage to the equipment.*

(4) Remove the liner bag, the moistureproof barrier, and the corrugated paper that cover the equipment inside the case.

Caution: When removing waterproofing and other protective wrappings, care should be taken not to remove moistureproof and fungiproof coatings.

(5) Remove the equipment from its case and place near its final location.

(6) Thoroughly inspect the equipment and spare parts for possible damage during shipment.

(7) Check the components of the set against the master packing slip and against the list of components in paragraph 86, appendix I.

15. Repacking Instructions

a. If this equipment is to be repacked for troop movements or is to remain out of service for some time, the line and local connections should be removed, the power cord coiled inside the case, and the cover closed and fastened.

b. If the repeater is to be placed in storage the following steps should be taken.

(1) Disconnect the power cord and coil the cord inside of the case. Disconnect all wiring to the binding posts. If teletypewriter power and transmission cords are connected they should be disconnected.

(2) Secure in place all spare parts, and any loose parts.

(3) Place technical manuals in the canvas pocket and fold pocket over repeater panel.

(4) Close the front cover and fasten in place.

(5) Place the repeater in a dry location.

(6) Inspect at reasonable intervals to see that the equipment is clean, free from rust, and has not been damaged. Clean and repair if necessary.

(7) If the equipment is left in storage for more than 18 months, the electrolytic filter capacitors of the power supply lose their film and should be restored. (See par. 84.)

PART TWO

OPERATING INSTRUCTIONS

Note. For information on destroying this equipment to prevent enemy use, see the destruction notice at the front of this manual.

Section IV. EQUIPMENT CONNECTIONS AND INITIAL ADJUSTMENTS

16. General

Before Repeater TG–30 can be placed into service and the system lined up for operation, the equipment must be connected and certain preliminary adjustments made. Connections are required between Repeater TG–30 and the line, between the repeater and the local equipment, and to ground. These connections are covered in paragraphs 17, 18, and 19. The preliminary adjustments consist of the proper setting of the LINE and LOCAL switches for the types of operation to be used and the arrangement of the power supply for the external power source. Line and local switch positions and power supply arrangements are covered in paragraphs 20, 21, and 22.

Caution: Connections should not be made to the external power supply until the line and local connections have been made, the LINE and LOCAL switches set, and the power supply arranged for the external power source.

17. Grounding Arrangements

a. A ground is required at each repeater to supply the return circuits for line and local connections, and to minimize the hazard to the equipment and personnel from lightning and other sources of high voltage.

b. Since this equipment operates on ground-return circuits, the resistance of the connection to earth is equal in importance to the resistance of the metallic-line conductor. Every effort should be made to obtain the best ground available in the area where service is to be established. Where a buried water supply piping system is available, the repeater equipment should be grounded to it; No. 14 gauge wire or its equivalent, should be used, although larger gauge wire may be required for mechanical strength. It is preferable to run a ground lead a few miles to a water pipe system rather than to drive ground rods in soil not well covered with vegetation or in dry soil.

c. When a buried water-supply piping system cannot be used for a ground, the best practical ground should be used. For example, use buried gas pipes, underground tanks or other buried metallic structures, or driven rods. When driven rods are used, drive them to their full length and, except when the earth is moist, drive two rods at least 25 feet apart. For detailed information on approved grounding procedures see TM 11–755.

18. Connections to the Line

a. The external connections to Repeater TG–30 for the different types of line operation are shown in figures 18 to 22. No provision is made for closing the cover when the power cord and line and local connections are brought out of and into the equipment, so caution should be taken to see that the power cord and other wires are not damaged by lowering the cover when equipment is in operation. The following connections should be made before starting to line up the equipment.

b. Connect the GND binding post to ground, as specified in paragraph 17, for all forms of line and local operation.

c. Connect the line wires to the line binding posts in accordance with the following:

(1) For line operation from one Repeater TG–30 to the distant Repeater TG–30 (fig. 18) connect the line wire to the LINE 1 binding post at both terminal A and terminal B.

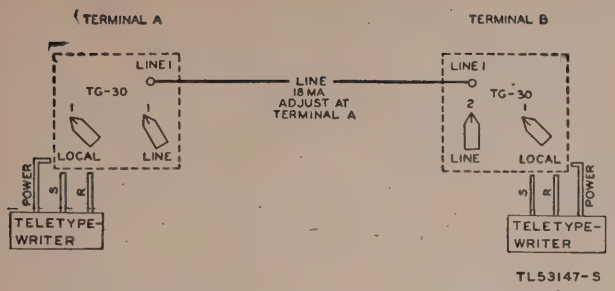


Figure 18. Terminal-to-terminal with teletypewriter.

(2) For line operation with an intermediate Repeater TG–31 (fig. 19) connect the line wire to the LINE 1 binding post at both terminal A and terminal B.

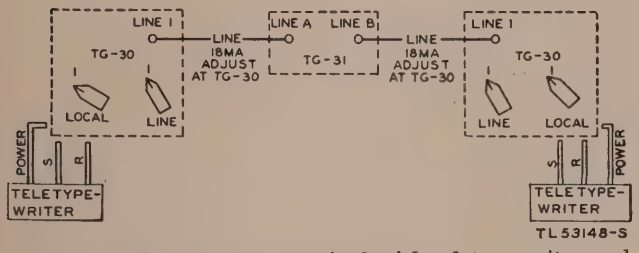


Figure 19. Terminal-to-terminal with teletypewriter and with Repeater TG–31 (Intermediate, Telegraph).

(3) For line operation on a two-path polar basis (fig. 20) connect one line at terminal A to the LINE 1 binding post. Connect the other end of this line to the LINE 2 binding post at terminal B. At terminal A, connect the other line to the LINE 2 binding post and at terminal B connect the second line to the LINE 1 binding post. Care should be taken that these line connections are not reversed or the sending portion of one repeater will be connected to the sending portion of the other repeater.

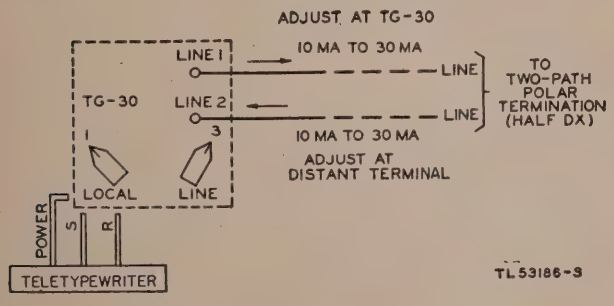


Figure 20. Two-path polar operation.

(4) For line operation with carrier telegraph terminal on a half-duplex basis (fig. 21), connect the line wire to the LINE 1 binding post. The other end of the line should be connected to binding post SL if Telegraph Terminal CF–2–A, Telegraph Terminal CF–2–B, Telegraph Terminal CF–6, or Telegraph Terminal TH–1/TCC–1 is used. If Carrier Terminal OA–4/FC or OA–5/FC is used the wire should be connected to the T SEND terminal.

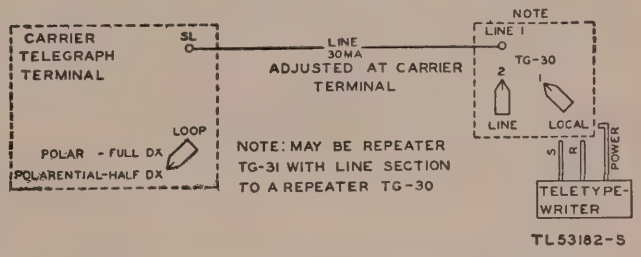


Figure 21. Line operation (half-duplex) with carrier telegraph terminal.

(5) For line operation with a carrier telegraph terminal on a full-duplex basis (fig. 22) connect one line to the LINE 1 binding post of the sending Repeater TG–30. The other end of this line should be connected to the SL binding post (or its equivalent as indicated in par. *c*(4) above) at the carrier telegraph terminal. Connect the other line to the LINE 1 binding post of the receiving Repeater TG–30. The other end of this line should be connected to binding post RL if Telegraph Terminal CF–2–A, Telegraph Terminal CF–2–B, Telegraph Terminal CF–6, or Telegraph Terminal TH–1/TCC–1 is used. If Carrier Terminal OA–4/FC or OA–5/FC is used the wire should be connected to the T REC terminal. Care should be taken to see that these line connections are not reversed, because operation is impossible under such conditions.

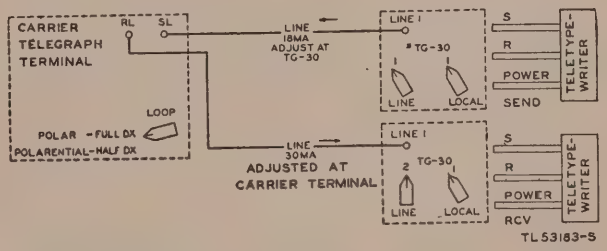


Figure 22. Line operation (full-duplex) with a carrier telegraph terminal.

19. Connections to Local Equipment

a. For local operation with Teletypewriter TG–7–B (fig. 18) connect the teletypewriter cord with the red plug to the PRINTER jack marked R RED. This is the selector magnet circuit. Connect the cord with the black plug to the PRINTER jack marked S BLK. This is the sending contacts circuit. Connect the teletype-

writer power cord to the receptacle marked PRINTER POWER. This circuit supplies power to the teletypewriter motor.

b. For other types of local equipment connect the local wires to the local binding posts in accordance with the following:

(1) For local operation with Switchboard BD–100 or Line Unit BE–77–(*) (fig. 23) connect LOCAL binding post 1 on the repeater to a LINE terminal in the switchboard, or the LINE terminal on the line unit.

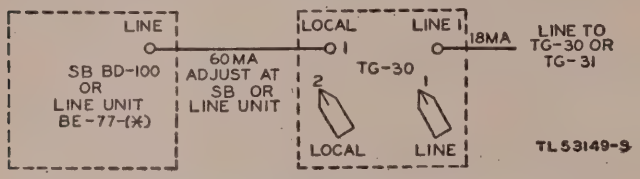


Figure 23. Local operation with Switchboard BD–100 or Line Unit BE–77–(*).

(2) For local operation with a teletypewriter equipped with a line relay (fig. 24), connect the line wire to LOCAL 1 binding post at Repeater TG–30 and to the line terminal at the teletypewriter.

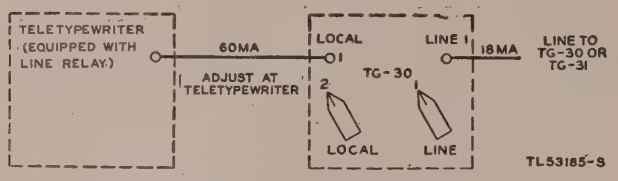


Figure 24. Local operation with a teletypewriter equipped with a line relay.

(3) For local operation with a carrier telegraph terminal (fig. 25) connect wires from LOCAL binding posts 1 and 2 of the repeater to binding posts SL and RL (T SEND and T REC if Carrier Terminal OA–4/FC or OA–5/FC), respectively, of a telegraph channel in the carrier telegraph terminal.

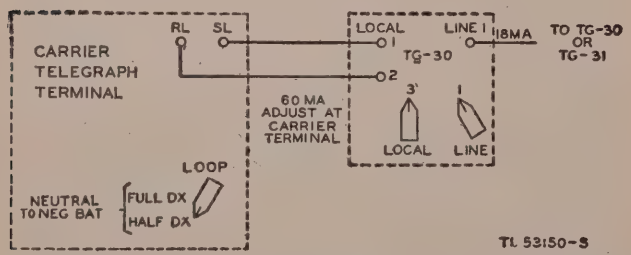


Figure 25. Local operation with a carrier telegraph terminal.

c. For local operation with the manual telegraph set, disconnect all teletypewriter cords. Connect the headset to jack designated HEAD SET.

d. When two Repeaters TG–30 are used to provide intermediate operation (fig. 26) connect LOCAL binding posts 1 to 1, LOCAL binding posts 2 to 2, and LOCAL binding posts 3 to 3. A teletypewriter may be connected to one of the repeaters as described in *a* above.

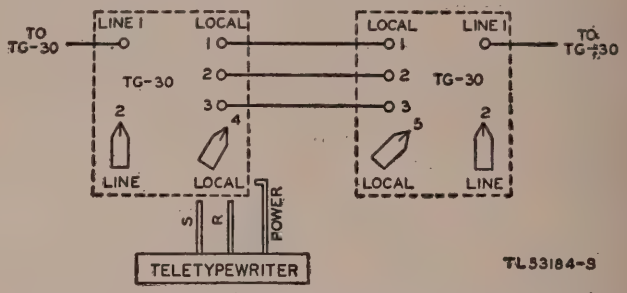


Figure 26. Intermediate operation with a teletypewriter using two Repeaters TG–30.

e. For local operation with Regenerative Repeater OA–3/FC (fig. 27), connect LOCAL binding post 1 of the first Repeater TG–30 to the S WEST terminal of Regenerative Repeater OA–3/FC. Connect LOCAL binding post 1 of the second Repeater TG–30 to the S EAST terminal of Regenerative Repeater OA–3/FC. Connect the power supply to Regenerative Repeater OA–3/FC. If Western Electric Co power supply unit X–61680B is used, connect a dummy load of about 2,000 to 3,000 ohms across each rectifier. Connect LOCAL binding post 2 of each Repeater TG–30 to negative 130 volts through a 1,600-ohm, 10-watt resistor (Signal Corps stock No. 3Z6160–15, or equivalent). The resistor limits the current in the local circuit so it can be adjusted to the required value.

Note. Power supply X–61680B is used in Telegraph Terminal CF–2–B (Carrier), and Telegraph Repeater OA–6/FC.

20. Line Switch Positions

a. The LINE switch is a three-position switch which, in combination with the LINE binding posts, provides the required line circuit arrangements. The proper position of the LINE switch for the various types of operation is covered in the following subparagraphs.

b. When operation is from Repeater TG–30 to Repeater TG–30 on a terminal-to-terminal basis (fig. 18) it is necessary to arrange the repeaters for polarential operation. The repeater at terminal A is arranged as the *polar-sending* repeater by setting the LINE switch on position 1. The repeater at terminal B is arranged as the *differential-sending* repeater by

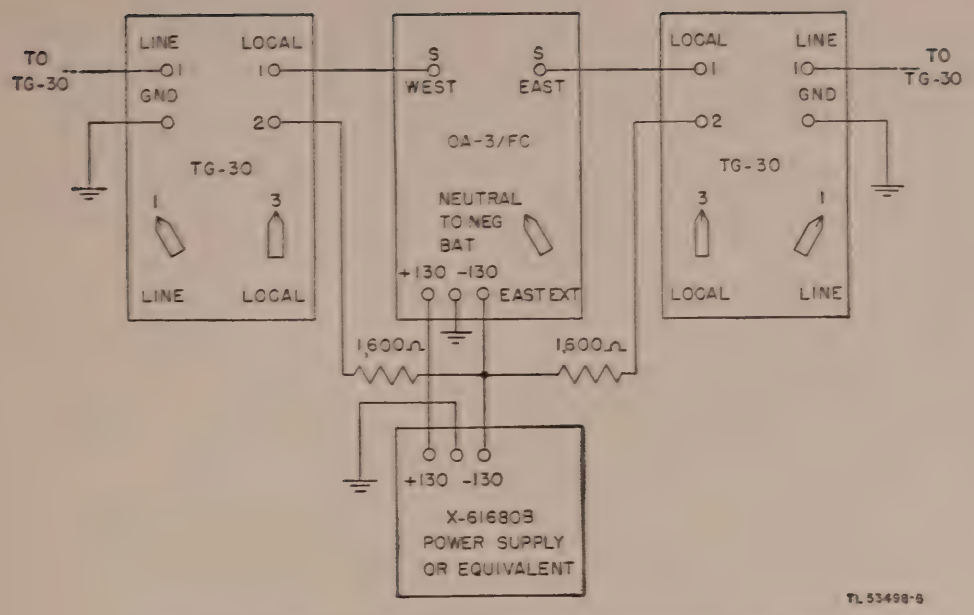


Figure 27. Local operation with Regenerative Repeater OA–3/FC.

setting the LINE switch on position 2.

c. When operation is on a terminal-to-terminal basis with Repeater TG–31 (fig. 19) both terminal repeaters are arranged as polar-sending repeaters by setting the LINE switch on position 1.

d. When line operation is to be on a two-path polar basis (fig. 20), set the LINE switch at both repeaters on position 3.

e. For polarential operation from Repeater TG–30 to a carrier telegraph terminal on a half-duplex basis (fig. 21) Repeater TG–30 is arranged as the differential-sending end of the system by setting the LINE switch on position 2. The carrier telegraph terminal is arranged as the polar-sending end of the system by turning the LOOP switch (DC EXTENSION switch for Carrier Terminal OA–4/FC or OA–5/FC) to POLARENTIAL HALF DX.

f. When line operation is on a full-duplex basis with a carrier telegraph terminal (fig. 22) each Repeater TG–30 is arranged for polarential operation (one as a polar-sending repeater and the other as a differential-sending repeater). On the Repeater TG–30, which *sends to* the carrier terminal, the LINE switch should be set on position 1. On the Repeater TG–30, which *receives from* the carrier terminal, the LINE switch should be set on position 2. The LOOP (or DC EXTENSION) switch at the carrier telegraph terminal should be turned to the POLAR-FULL DX position.

21. Local Switch Positions

a. The LOCAL switch is a five-position switch which, in combination with the LOCAL binding posts, provides the required local circuit arrangements. The LOCAL binding post connections are covered in paragraph 19. Any type of local operation may be used with any type of line operation, with the exception of full-duplex operation with a carrier telegraph terminal which requires a sending teletypewriter and a receiving teletypewriter. The proper position of the LOCAL switch for the various types of local operation is covered in the following subparagraphs.

b. When local operation consists of a teletypewriter with the transmission cords plugged into the PRINTER jacks, the LOCAL switch is set on position 1. (See fig. 18.)

c. When local operation is with Switchboard BD–100 or Line Unit BE–77–(*) (fig. 23), the LOCAL switch is set on position 2. Throw battery switch associated with the line used at Switchboard BD–100 to LINE CURRENT SUPPLIED BY SWITCHBOARD. Throw keys in the line unit to RELAY IN CIRCUIT and to LOCAL CURRENT SUPPLY. The preferred position for the LINE switch of Repeater TG–30 is polarential, polar-sending (position 1) or two-path polar (position 3). However, if necessary, the repeater may be operated with the LINE switch for polarential, differential-sending (position 2).

d. When local operation is with a teletypewriter equipped with a line relay (fig. 24) the LOCAL switch is set on position 2. The polar-neutral key at the teletypewriter should be operated to neutral.

e. When local operation is with a carrier telegraph terminal (fig. 25) the LOCAL switch is set on position 3. The LOOP (or DC EXTENSION) switch at the carrier telegraph terminal should be turned to the NEUTRAL TO NEG BAT-HALF DX position.

f. For manual telegraph set operation, the LOCAL switch should be turned to position 1.

g. When two Repeaters TG–30 are used for intermediate operation (fig. 26), the LINE switches on both repeaters should be set for the same form of polarential line operation, that is, position 1 or position 2. To be the equivalent of a Repeater TG–31 (Intermediate, Telegraph) both LINE switches should be set on position 2. The teletypewriter may be connected to one of the repeaters and the LOCAL switch of this repeater *must* be turned to position 4. The LOCAL switch of the other repeater *must* be turned to position 5.

h. When Regenerative Repeater OA–3/FC (fig. 27) is used with two Repeaters TG–30, the LOCAL switch on both Repeaters TG–30 is set on position 3. The EAST EXTENSION switch at Regenerative Repeater OA–3/FC should be turned to the NEUTRAL TO NEG BAT position.

22. Power Supply Arrangements

a. The repeater is arranged to operate on three different types of external power supply. Before making connections to the external power supply, the power switches must be properly arranged for the external power supply being used.

Caution: Serious damage may result to the repeater or connected teletypewriter if 115V–230V switch is not operated to the 230V position when power supply is 230 volts ac.

b. If the external power supply is ac, determine whether it is between 95 and 125 volts or between 190 and 250 volts, and 50 to 60 cycles. After determining which it is, open the small door on the right-hand forward position of the equipment and throw the toggle switch to 115V or 230V as required. Throw the master AC-DC power switch on the repeater unit to the position designated 115V OR 230V AC.

c. If the power supply is direct current, throw the master AC-DC power switch on the repeater unit to the position designated 115V DC.

d. If the LINE switch has been turned to position 1 or 3, turn the ADJ LINE CURRENT knob COARSE to the maximum counterclockwise position. This introduces sufficient resistance in series in the line to prevent blowing fuses when the line facility resistance is very low.

e. Connect the power cord to the power supply.

f. The power supply voltage is adjusted as follows:

(1) When a-c power is used, hold down the MEAS VOLTS key and turn the ADJUST VOLTS knobs designated COARSE and FINE until meter indicates 115 volts. This point is designated by a red line on the meter.

(2) When a d-c power supply is used, regulate the voltage to 115 volts at the source, and connect the power cord so that the meter on Repeater TG–30 reads to the right of zero when the MEAS VOLTS key is held down. Reverse power cord if meter reads to the left of zero.

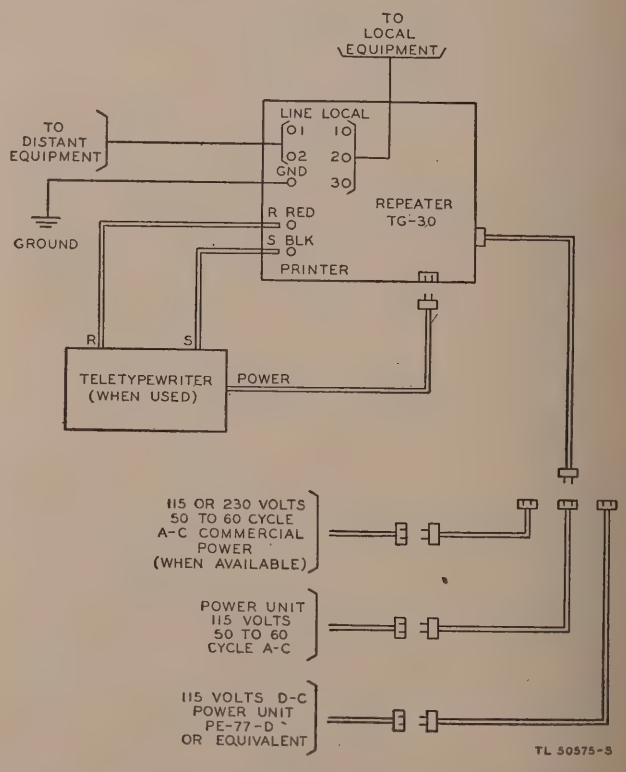


Figure 28. Cording diagram of power supply arrangements for Repeater TG–30 (Terminal, Telegraph).

23. Equipment Checks

Before lining up the system for operation, the polar relays in Repeater TG–30 should be checked. Test Set I–193–A should be used for testing and readjusting the polar relays. For detailed procedure on testing and adjusting the polar relays refer to TM 11–2513.

Section V. SYSTEM LINE-UP

24. General

System line-up for Repeater TG–30 consists of adjusting the currents in the line and local circuits to the prescribed values for the type of operation being used. In all local circuits, the currents are adjusted in the connected equipment and not in Repeater TG–30. The line-up procedure may require communication with personnel at the connected equipment. If means other than using the equipment being lined up are available, use such means to communicate. If other means of communication are not available a teletypewriter, connected as indicated in paragraph 19*a*, or the manual telegraph set may be used for this purpose. The current values and the adjustments required are covered in the following paragraphs.

25. Line Current Adjustments

a. Line operation may be either polarential or two-path polar. The procedure for adjusting the line current for these two types of operation and specific applications to various equipments are given below.

(1) *Polarential operation.* Line current is adjustable only at a Repeater TG–30 set up for polarential polar-sending (LINE switch in position 1). If the meter shows zero, the line may be open or the distant terminal not connected for service. With the ADJ LINE CURRENT knob COARSE in maximum counterclockwise position (par. 22*d*) turn the ADJ LINE CURRENT knob FINE to the maximum INCREASE position and the ADJ LINE CURRENT knob COARSE clockwise to the *first position* which gives at least 18 milliamperes. This point is designated by a red line on the meter. Request the distant terminal to send a spacing signal by holding down the break key of the teletypewriter or otherwise sending a long spacing signal. Read the spacing line current. If it is not 44 to 46 milliamperes, readjust in accordance with table III, taking into consideration the types of lines as shown. Any line-up subsequent to starting service should be made in accordance with table III. If the line-up requires a readjustment of line current on a space from the distant point, the marking line current will exceed 18 milliamperes.

Table III

Readjust spacing line current to be:			
Spacing line current	*104 Copper-steel and field wire*	*104 Copper*	*080 Copper-steel*
44 to 46 MA	No change	48 MA	44 MA
42 to 43	44	46	43
40 to 41	43	45	42
38 to 39	42	44	42
36 to 37	41	43	41
34 to 35	40	41	40
32 to 33	39	39	40
30 to 31	38	38	39
28 to 29	37	37	38
26 to 27	36	36	38

(2) *Two-path polar operation.* The line current is adjustable in the sending line only at Repeater TG–30 (LINE switch in position 3). The receiving line current is adjusted in the sending line at the distant terminal repeater. Turn the ADJ LINE CURRENT knobs COARSE and FINE to give the highest line current obtainable with the line facility used. However, the line current should not be less than 10 milliamperes and not more than 30 milliamperes.

b. For line operation on a terminal-to-terminal basis (fig. 18) the line current is adjustable at the repeater arranged for polar sending (terminal A). Line current should be adjusted as covered in *a*(1) above.

c. For line operation on a terminal-to-terminal basis with Repeater TG–31 (fig. 19) both Repeaters TG–30 are arranged as polar-sending repeaters. Line current should be adjusted as covered in *a*(1) above.

d. For line operation with a carrier telegraph terminal on a half-duplex basis (fig. 21), the line current should be adjusted to 30 milliamperes at the carrier equipment.

e. For line operation with a carrier telegraph terminal on a full-duplex basis (fig. 22), the line current in the line which *sends from* Repeater TG–30 should be adjusted to 18 milliamperes at Repeater TG–30, and the current in the line which *sends from* the carrier telegraph terminal should be adjusted to 30 milliamperes at the carrier terminal.

26. Local Current Adjustments

a. LOCAL OPERATION WITH SWITCHBOARD BD–100 OR LINE UNIT BE–77–(*) (fig. 23). The power for the local circuit is furnished by the switchboard or line unit. Adjust local current to 60 milliamperes by using the rheostat in the switchboard line circuit or the rheostat in the line unit. Connect the line unit power cord to its rectifier so as to furnish negative 115 volts to the LINE terminal connected to Repeater TG–30. When using Switchboard BD–100 better reception will be obtained at the switchboard if line relay WEST is adjusted spacing, using the switchboard bias meter circuit. Determine the amount of spacing bias by test.

b. LOCAL OPERATION WITH A TELETYPEWRITER EQUIPPED WITH A LINE RELAY (fig. 24). A variable 2,000-ohm resistance should be used in series at the teletypewriter and the current adjusted to 60 milliamperes. Adjust the teletypewriter station rectifier to 120 volts when the line is closed and the selector magnet connected. The bias current of the line relay in the station should be 30 milliamperes. The preferred position for the LINE switch of Repeater TG–30 is polarential, polar sending (position 1).

c. LOCAL OPERATION WITH A CARRIER TELEGRAPH TERMINAL (fig. 25). The local current should be adjusted to 60 milliamperes using the potentiometer in the sending loop of the carrier terminal. The local current is indicated on the meter in the carrier terminal.

d. MANUAL TELEGRAPH SET. The power used for operating the repeater on teletypewriter circuits is also required for manual telegraph operation. Hold down the telegraph key and adjust the tone heard in the headset to suit the using personnel by turning knob designated ADJ TONE. When the distant terminal is using a teletypewriter, send a number of long dashes (or some other prearranged code) as a signal that manual telegraph operation is desired. The teletypewriter at the distant station runs open while the telegraph key is held down.

e. INTERMEDIATE OPERATION WITH A TELETYPEWRITER USING TWO REPEATERS TG–30 (fig. 26). With this type of operation the local circuit arrangements are such that no local current adjustment is necessary.

f. LOCAL OPERATION WITH REGENERATIVE REPEATER OA–3/FC (fig. 27). The local current in the east and west extension circuits is adjusted to 60 milliamperes at Regenerative Repeater OA–3/FC, by adjusting the SEND EXT RESISTANCE E potentiometer and the SEND EXT RESISTANCE W potentiometer.

Section VI. SUMMARY OF PROCEDURE FOR PLACING EQUIPMENT IN SERVICE

27. Line-up Procedure

The steps required for placing Repeater TG–30 into service should be performed as follows (fig. 29):

a. Connect ground wire to GND binding post (1).

b. Connect line wire to LINE 1 binding post (2) for polarential operation. Connect sending line to LINE 1 binding post and receiving line to LINE 2 binding post for two-path polar operation.

c. For local operation with Teletypewriter

TG–7–B connect red plug to RED jack R (18), connect black plug to BLK jack S (17), and connect teletypewriter power cord to PRINTER POWER receptacle (8). For other types of local operation connect local wires as follows:

(1) With Switchboard BD–100, Line Unit BE–77–(*), or teletypewriter equipped with a line relay, connect wire to LOCAL 1 binding post (3).

(2) With Telegraph Terminal CF–2–A, Telegraph Terminal CF–2–B, Telegraph Terminal CF–6, or Telegraph Terminal TH–1/TCC–1, connect LOCAL 1 binding post to SL and LOCAL 2 binding post to RL in the carrier telegraph terminal.

(3) With Carrier Terminal OA–4/FC or OA–5/FC, connect LOCAL 1 binding post to T SEND and LOCAL 2 binding post to T REC in the carrier telegraph terminal.

(4) For intermediate operation with two Repeaters TG–30, connect binding posts LOCAL 1 to LOCAL 1, LOCAL 2 to LOCAL 2, and LOCAL 3 to LOCAL 3.

(5) With Regenerative Repeater OA–3/FC, connect LOCAL 1 binding post to S WEST or S EAST (as required) and connect LOCAL 2 binding post to negative 130 volts through 1,600 ohms.

d. Turn LINE switch (5) to:

(1) Position 1 for polarential, polar sending (terminal A).

(2) Position 2 for polarential, differential sending (terminal B).

(3) Position 3 for two-path polar.

e. Turn LOCAL switch (4) to:

(1) Position 1 for Teletypewriter TG–7–B or manual telegraph operation.

(2) Position 2 for Switchboard BD–100, Line Unit BE–77–(*), or teletypewriter equipped with a line relay.

(3) Position 3 for carrier telegraph terminal or Regenerative Repeater OA–3/FC.

(4) Position 4 for intermediate operation (direction A with teletypewriter, if required).

(5) Position 5 for intermediate operation (direction B without teletypewriter).

f. Turn ADJ LINE CURRENT switch knob (7) COARSE to maximum counterclockwise position if LINE switch is in position 1 or 3.

g. If power supply is ac, open panel (13) and throw switch (14) to 115V AC or 230V AC as required. Throw power switch (10) to 115V OR 230V AC position. A-c power must be 50 to 60 cycles. If power supply is dc, throw power switch (10) to 115V DC position.

h. Connect power cord (9) to power supply.

i. For a-c power supply, hold down MEAS VOLTS key (11) and turn ADJ VOLTS knobs (15) COARSE and FINE until meter reads 115V. For d-c power supply hold down MEAS VOLTS key and adjust voltage at source. Turn over power cord if meter reads to left of zero.

j. At a repeater arranged for polar sending (LINE switch in position 1) turn ADJ LINE CURRENT knob (7) FINE to maximum clockwise position. Turn COARSE knob clockwise to first position that gives at least 18 MA. Turn FINE knob as required to give 18 MA. Request distant terminal to send spacing signal for about 10 seconds by holding down break key of teletypewriter. Read space current and adjust space current, if not 44 to 46 milliamperes, in accordance with table III.

k. At a repeater arranged for two-path polar operation (LINE switch in position 3) adjust current in the sending line to 30 MA by ADJ CURRENT knobs.

l. Adjust local current in the connected equipment to 60 milliamperes.

m. For manual telegraph operation remove all teletypewriter cords. Connect headset to HEADSET jack (12). Turn ADJ TONE knob (16) to suit using personnel while operating telegraph key.

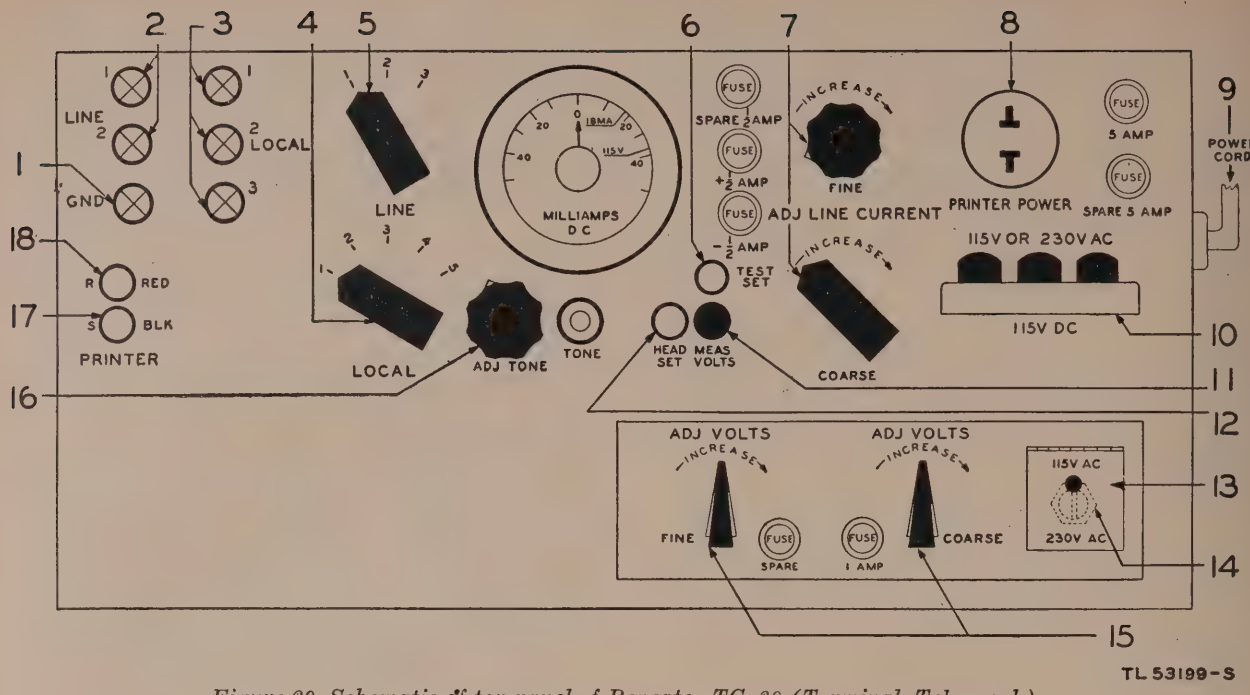


Figure 29. Schematic of top panel of Repeater TG–30 (Terminal, Telegraph).

Section VII. ROUTINE CHECKS OF PERFORMANCE

28. Records

a. It is advisable at each station to maintain a record showing when each periodic test or line-up is made, the values of the line current, and the troubles found and when and how they are cleared. Such records will indicate which equipment and circuits should be given the most attention and may also be useful in locating conditions causing circuit failures.

b. Forms for recording such data may be improvised and should be made to cover transmission in both directions, results of over-all system line-up, and operating adjustments. These forms may be designed to cover the results for a single day, or for several days, if experience indicates that the number of adjustments permits such usage. The suggested forms given below may be changed to suit using personnel.

Trouble record

Reported			Report	Disposition	Cleared		
Date	Time	By			Date	Time	By
2 May	0915	RBS	System out of service.	Replaced broken wire to GND binding post.	2 May	0925	RBS
5 May	1535	PCP	Errors in received copy.	Replaced receiving relay.	5 May	1600	PCP
8 May	2105	JSE	High d-c output voltage.	Broken connection on resistor R.	8 May	2300	JSE

System Line-up

Date	LINE switch position	LOCAL switch position	Marking line current	Spacing line current
2 May	1	1	18 ma	45 ma
3 May	1	1	18 ma	45 ma
4 May	1	1	18 ma	44 ma
5 May	1	1	17 ma	43 ma

29. Purpose and Use of Check List

a. GENERAL. The equipment performance check list (par. 30) will help the operator determine whether Repeater TG–30 is functioning properly. The check list gives the item to be checked, the conditions under which the item is checked, the normal indications, and the corrective measures that the operator can take. Items 6 to 14 correspond to the initial line-up

of the system and are checked when the system is about to go into operation after having been shut down. Items 15 and 16 correspond to the daily measurements which are made during operation.

b. ACTION OR CONDITION. For some items, the information given in the action or condition column consists of the settings of various switches and controls under which the item is to be checked. For other items, it represents an action that must be taken in order to check the normal indication given in the normal indication column.

c. NORMAL INDICATIONS. The normal indications include the visible and audible signs that the operator will find when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. CORRECTIVE MEASURES. The corrective measures listed are those that the operator can make without turning the equipment in for repairs. If the recommended corrective measures do not yield results, trouble locating by an experienced repairman is necessary. However, if the tactical situation requires that communication be maintained, and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

30. Equipment Performance Check List for Repeater TG–30 (Terminal, Telegraph)

	Item No.	Item	Action or condition	Normal indication	Corrective measures
PREPARATORY	1	GND binding post.	Ground wire connected to GND binding post.		
	2	LINE binding posts.	Line wires connected to LINE binding posts in accordance with paragraph 18*c*.		
	3	LOCAL binding posts.	Local wires connected to LOCAL binding posts in accordance with paragraph 19.		
	4	LINE switch.	LINE switch set in accordance with paragraph 20.		
	5	LOCAL switch.	LOCAL switch set in accordance with paragraph 21.		
START	6	ADJ LINE current knob COARSE.	Turn to maximum counterclockwise position.		
	7	Master AC-DC power switch.	Operate to position required for type of power supply used.		
	8	115V AC—230V AC switch.	Operate to position required when power supply is ac.		
	9	Power cord.	Connect to power supply.		
	10	MEAS VOLTS key.	Hold down.	Meter reading 115 volts.	Adjust ADJ VOLTS knobs if power supply is ac. Adjust voltage at source if power supply is dc.
	11	Voltage reading on meter. Power supply d-c.	Meter reads to left of zero.	Meter reads to right of zero.	Turn over power cord connection.
	12	Line current meter.	LINE switch in position 1 or 3.	Meter reading 18 ma.	Adjust ADJ LINE CURRENT knobs.
	13	HEADSET.	Insert plug in HEADSET jack. Hold down telegraph key.	Tone in headset.	Replace neon lamp.
	14	ADJ TONE knob.	Hold down telegraph key.	Tone in headset.	Adjust to suit using personnel.
EQUIPMENT PERFORMANCE	15	MEAS VOLTS key.	Hold down.	Meter reading 115 volts.	Adjust ADJ VOLTS knobs if power supply is ac. Adjust voltage at source if power supply is dc.
	16	LINE current meter.	LINE switch in position 1 or 3.	Meter reading 18 ma.	Adjust ADJ LINE CURRENT knobs.

PART THREE

PREVENTIVE MAINTENANCE

Section VIII. PREVENTIVE MAINTENANCE TECHNIQUES

31. Meaning of Preventive Maintenance

Preventive maintenance is a systematic series of operations performed periodically on equipment in order to maintain top efficiency in performance, to minimize unwanted interruptions in service, and to eliminate major break-downs. To understand what is meant by preventive maintenance, it is necessary to distinguish between preventive maintenance and trouble locating and repair. The primary function of preventive maintenance is to *prevent* breakdowns and the need for repair. On the other hand, the primary function of trouble locating and repair is to locate and correct *existing* defects. The importance of preventive maintenance cannot be overemphasized. The usefulness of the entire system of communication depends upon the equipment being ready to operate at peak efficiency when needed.

Note. The operations in section VIII, Preventive Maintenance Techniques, are first and second echelon (organization operators and repairmen) maintenance. Some operations in section XI, Moistureproofing and Fungiproofing, are higher echelon maintenance.

32. Description of Preventive Maintenance Techniques

a. GENERAL. Most of the electrical parts used in Repeater Set TC–18 require routine preventive maintenance. Those requiring maintenance differ in the amount and kind required. Because maintenance techniques cannot be applied indiscriminately, definite and specific instructions are needed. This section of the manual contains this type of specific instructions and serves as a guide for personnel assigned to perform the six basic maintenance operations: namely, FEEL, INSPECT, TIGHTEN, CLEAN, ADJUST, LUBRICATE. Throughout this manual the lettering system for the six operations will be as follows:

F—Feel
I—Inspect
T—Tighten
C—Clean
A—Adjust
L—Lubricate.

The first two operations establish the need for the other four. The selection of operations is based on a general knowledge of field requirements. For example, the dust encountered on dirt roads during cross-country travel filters into the equipment no matter how much care is taken to prevent it. Rapid changes in climatic conditions (such as heavy rains followed by blistering heat) or excessive dampness, snow, and ice, tend to cause deterioration of exposed surfaces and parts.

b. FEEL (F). The feel operation is used to determine if electrical connections, transformers, filters, etc., are overheated. Feeling indicates the existence of some type of defect requiring correction. The maintenance man must become familiar with the normal operating temperatures of transformers, etc., in order to recognize signs of overheating.

Note. It is important that the feel operation be performed as soon as possible after the shut-down, and always before any other maintenance is done.

c. INSPECT (I). (1) *General.* Inspection is probably the most important of all the preventive maintenance operations. If more than one man is available to do this work, choose the most observant, for careful observation is required to detect defects in the functioning of moving parts and other abnormal conditions. To carry out the inspection operation most effectively, make every effort to become thoroughly familiar with normal operating conditions and to be able to recognize and identify abnormal conditions readily.

(2) *Inspection.* Inspection consists of carefully observing all parts in the equipment, noticing their color, placement, cleanliness, etc.

Inspect for the following conditions:

(*a*) Overheating, as indicated by discoloration, blistering, or bulging of the part or surface of the container; leakage of insulating compounds; and oxidation of metal contact surfaces.

(*b*) Placement, by observing that all leads and cabling are in their original positions.

(*c*) Cleanliness, by carefully examining all recesses in the units for accumulated dust, especially between connecting terminals. Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high humidity locations, look for fungus growth and mildew.

(*d*) Tightness, by testing any connection or mounting which appears to be loose, by slightly pulling on the wire, or by feeling the lug or terminal screw.

d. TIGHTEN (T). Any movement of the equipment caused by transportation, by concussion from falling shells, or by vibration from moving machinery, may result in loose connections which are likely to impair the operation of the repeater. The importance of firm mountings and connections cannot be overemphasized; however, never tighten screws, bolts, and nuts unless it is known definitely that they are loose. Fittings that are tightened beyond the pressure for which they are designed will be damaged or broken. When tightening, always be certain to use the correct tool of the proper size.

e. CLEAN (C). When the schedule calls for a cleaning operation, it does not mean that every item which bears that identifying letter must be cleaned each time it is inspected. Clean parts only when inspection shows that it is necessary. The cleaning operation to be performed on each part is described in the paragraph pertaining to that item.

Note. Gasoline will not be used as a cleaning fluid for any purpose. Solvent, Dry-cleaning, is available as a cleaning fluid through established supply channels. Oil, Fuel, Diesel, may be used for cleaning purposes when dry-cleaning solvent is not on hand. Carbon tetrachloride will be used as a cleaning fluid only where specified for cleaning contact parts of electrical equipment, or as specified where inflammable solvents cannot be used because of the fire hazard. Oil, Fuel, Diesel, *will not* be used for cleaning electrical contacts.

f. ADJUST (A). Adjustments are made only when necessary to restore normal operating conditions. Specific types of adjustment are described in the paragraph pertaining to the particular item.

g. LUBRICATE (L). Lubrication means the addition of oil or grease to form a film between two surfaces that slide against each other, in order to prevent mechanical wear from friction. Generally, lubrication is performed only on motors, engines, and shafts.

33. Repeater TG–30, Exterior

a. INSPECT (I). Carefully examine the case and front panel of the repeater for broken or damaged places, chipped paint, dirt, dust, rust, corrosion, and loose or missing screws. Carefully inspect the corners and small crevices for dirt, dust, and lint.

b. TIGHTEN (T). Tighten all loose screws in the repeater with a suitable screw driver. Pay particular attention to the screws in the front panel and the four mounting screws which hold the repeater in the case. All screws should be tightened snugly, but not forced.

c. CLEAN (C). With a soft, dry cloth wipe off all dirt, dust, and lint on the repeater case and on the front panel. Do not use soap and water at any time.

34. Power Cord

a. INSPECT (I). Inspect the power cord for cracked or deteriorated insulation, or frayed or cut insulation. A badly damaged cord may cause a short circuit on the power supply.

b. CLEAN (C). Clean the power cord with a dry cloth. Remove grease and oil and other foreign matter with Solvent, Dry Cleaning, Federal spec. No. P–S–661a. Do not use soap and water at any time.

35. Fuses

a. INSPECT (I). Inspect the fuses for dirt, dust, and corrosion. Carefully examine the fuse holders for dirt, dust, or corrosion.

b. CLEAN (C). Clean the fuses with a soft bristle brush. Brush all dirt, dust, and foreign matter out of the fuse holders.

36. Headset

a. INSPECT (I). Inspect the headset for chipped places, dirt, dust, rust, and corrosion. Inspect the exterior only.

b. CLEAN (C). Clean the headset with a clean, dry cloth. Wipe off the exterior only. Do not attempt to clean any part of the interior of the headset.

37. Ground Rods

a. INSPECT (I). Inspect the ground rod for rust and corrosion.

b. TIGHTEN (T). Tighten the thumbscrew at the connection. Do not use pliers to tighten this thumbscrew.

38. Relays

a. GENERAL. In applying preventive maintenance to the polar relays it is essential that maintenance personnel familiarize themselves with all details of the relay by examining it while it is in good condition. In this way, they will be prepared to recognize defects which will affect operation of the relay. Extreme care should be used when handling the relay so as not to damage or misalign the relay mechanism.

b. INSPECT (I). (1) A relay is considered to be in good operating condition if:

(*a*) The exterior is free from dirt and dust.

(*b*) The relay assembly is securely mounted.

(*c*) The relay coil shows no signs of overheating.

(*d*) The wire insulation is not frayed or torn.

(*e*) The connections to the relay are tight.

(*f*) The contacts are lined up and correctly spaced.

(*g*) The contact springs are in good condition.

(*h*) The armature travels freely and functions satisfactorily.

(*i*) The contacts are not burned, pitted, or corroded.

(2) If the relay fails to meet requirements in *f* to *i* above, see paragraph 76*b*.

(3) Inspect to see if gas adsorber units are in place. If no gas adsorber units are present in the relay they should be installed immediately. (See par. 83*g*.) If gas adsorber units are present they should be replaced if there is excessive corrosion of the relay contacts and a formation of black dust on the relay frame below the contacts.

c. TIGHTEN (T). Tighten all loose connections and mounting screws, but do not apply enough force to damage the screws or break the parts.

d. CLEAN (C). Invert the relay cover and tap it to loosen dirt, then wipe it with a clean, dry, lintless cloth.

39. Meter

The meter is an extremely delicate instrument and must be handled very carefully. It requires very little maintenance. It is a precision instrument and cannot be repaired in the field. A damaged meter should be replaced with a spare and returned to the depot for repair.

a. INSPECT (I). Inspect the leads and connections to the meter. Look for loose, dirty, and corroded connections. Look for cracked or broken cover glass. Since the movement of a meter is extremely delicate, its accuracy will be seriously affected if the glass is broken and dirt and water filter through.

b. TIGHTEN (T). Tighten all loose connections and screws. Inspect all loose meter wires for dirt or corrosion before they are tightened. The tightening of meter connections requires a special technique, because careless handling can easily crack the meter case. To prevent breakage, hold firmly the retaining nut which makes contact with the meter case, while the outside nut is being tightened. This permits the tightening of the connections without increasing the pressure of the head of the stud against the inside of the meter case.

c. CLEAN (C). (1) Meter cases are made of hard, highly polished bakelite, and can usually be cleaned with a dry cloth. If cleaning is difficult, the cloth should be dampened with dry-cleaning fluid. Clean dirty connections with a small stiff brush dipped in dry-cleaning fluid or with a small piece of cloth dipped in solvent. Since solvents do not entirely remove dirt from hard surfaces, some of the dirt will be left in a softened state and must be removed with a clean cloth.

(2) Clean corroded connections by sanding them lightly with a very fine grade of sandpaper, such as No. 0000. After they are cleaned, wipe the connections carefully with a clean cloth.

d. ADJUST (A). Normally, meters should indicate 0 when the equipment is turned off. The procedure for setting a meter on 0 is not difficult, and requires only a screw driver. Before adjusting the meter, tap the meter case lightly with the tip of one finger. This will help the meter to overcome the slight friction which sometimes exists at the bearings and prevents an otherwise normal unit from coming to rest at 0. If adjustment is needed, insert the tip of the screw driver in the slotted screw head located in the center of the meter glass and slowly turn the adjusting screw until the pointer is at 0. View the meter face and pointer "full on," and not from either side. Avoid turning the

screw too far, because the needle may be bent or the hairspring damaged.

40. Binding Posts

a. INSPECT (I). Inspect the binding posts on the repeater for dirt, dust, rust, and corrosion. Carefully examine for loose binding posts.

b. TIGHTEN (T). Tighten any loose binding posts. Do not exert too much force or the binding posts may be damaged.

c. CLEAN (C). Clean the binding posts with a soft bristle brush.

41. Protectors

a. INSPECT (I). Inspect the protectors to make sure that the carbon blocks are smooth and not pitted and that the assembly is free from dust and dirt. An inspection is recommended after every lightning storm in the area.

b. CLEAN (C). Wipe the carbon block and the porcelain block including the carbon insert with a dry, lintless cloth. Discard any cracked or pitted blocks and any which cannot be wiped smooth. Do not rub blocks together and do not use a file or abrasive.

42. Telegraph Key

a. INSPECT (I). Inspect the telegraph key for proper operation and for dirt, dust, and corrosion.

b. TIGHTEN (T). Tighten all loose connections on the telegraph key.

c. CLEAN (C). Clean the telegraph key with a soft bristle brush. Use the brush dipped in dry-cleaning fluid to remove excessive foreign matter.

43. Wiring

a. GENERAL. The preventive maintenance procedure for wiring is intended for all connections used on Repeater TG–30. The term wiring as used in preventive maintenance is intended to include all wiring and cabling placed at the factory. The wiring can be regarded as the life lines of the equipment. The condition of the wiring must be closely observed. Equipment operated under all kinds of weather conditions and moved on all kinds of roads, subjects wiring to a great deal of punishment.

b. INSPECT (I). (1) Inspect the wiring for cracked or deteriorated insulation, frayed or cut insulation at the connecting and supporting points, and improper placement which places the wiring or connections under strain. Watch for kinks and improper supports.

(2) Several ground connections are used in the wiring system. These should be kept clean and tight. If any one of the grounded points is open, it may interfere with the operation of the equipment.

(3) If the frame of the equipment is grounded at a loose point, the loose connection nullifies protection for the operating personnel.

c. TIGHTEN (T). Tighten loose fasteners, cable clamps, coupling rings, wiring connections, etc.

44. Keys and Switches

a. INSPECT (I). (1) Inspect the mechanical action of each key or switch and look for signs of dirt or corrosion on all exposed elements. In some cases, examine the elements of the key or switch visually; in others, examine the action of the key or switch by flipping the control knob or toggle, or by pressing the switch button and noting the freedom of movement and the amount of spring tension. Inspect the gang switches visually to see if the contacts are clean. Do not pry the leaves of the switch apart. Some contacts are silver-plated and do not corrode easily. The rotary member should make good contact with the stationary member, and as the former slides into the latter a spreading of the contact leaves should be noticeable.

(2) For inspection, remove the covers on push-button switches. Press each button and observe the action of the switch elements. The springs should have ample tension, the switch action should be free, and the contacts should be clean. Brown or black stain on a silver-plated contact should not be confused with dirt or corrosion, it is silver oxide and is a satisfactory conductor. The wiping action of the contacts usually removes the silver oxide at the point of contact.

b. CLEAN (C). Clean the exterior surfaces of keys and switches with a stiff brush moistened with dry-cleaning fluid, and polished with a piece of cloth. Clean corroded contacts with No. 0000 sandaper. Clean all dirty contacts with a cloth or brush dipped in dry-cleaning fluid. After cleaning, polish the contacts with a dry cloth.

45. Potentiometers

a. INSPECT (I). (1) Inspect the mechanical condition of the ADJ TONE and ADJ LINE

CURRENT (FINE) potentiometers. The shaft should turn easily in the bushing which supports it. On the ADJ LINE CURRENT (FINE) potentiometer the arm should be keyed tightly to the shaft. Poor contact between the arm and the resistor winding is caused by insufficient tension in the arm.

(2) Inspect the assembly and mounting, setscrews holding the knob, and the mounting nut.

(3) Inspect the insulating bodies of the potentiometers for dust, cracks, and chipped places.

(4) Inspect all metallic parts for dust, dirt, and corrosion. The ADJ LINE CURRENT (FINE) potentiometer has a small brush attached to the sliding arm. This brush should be inspected and replaced when excessive wear is noted.

b. TIGHTEN (T). Tighten the mounting nut or setscrews if they are loose. To tighten the mounting nut it is necessary to remove the knob. Loosen the setscrews and remove the knob. Tighten the mounting nut and replace the knob. Be sure the body of the potentiometer does not turn while the mounting nut is being tightened.

c. CLEAN (C). (1) Clean the body of the potentiometer and the connections whenever they are dirty. Clean the contact surface of the resistance winding and the sliding contact on the ADJ LINE CURRENT (FINE) potentiometer. To clean the contact surface of the arm, insert a strip of crocus cloth between the arm and the resistance winding and draw the cloth back and forth. A crocus stick is recommended.

(2) Remove grease and dirt from the potentiometer parts with dry-cleaning fluid, if necessary; otherwise, clean with a brush or cloth.

d. ADJUST (A). Adjust the tension in the contact arm of the ADJ LINE CURRENT (FINE) potentiometer to insure positive contact. Use a pair of long-nose pliers to spring the arm slightly in the direction in which tension is desired. Work the pliers along the length of the contact arm and put a slight bow in it. Do not damage the winding.

e. LUBRICATE (L). If the shaft turns hard in its bushing, a drop or two of special preservative lubricating oil (PS) may be placed on the shaft at each end of the bushing. The contact surfaces of the ADJ LINE CURRENT (FINE) potentiometer are lubricated with a very thin film of petrolatum. After lubrication, the surrounding surfaces must be wiped with a dry cloth.

46. Terminal Blocks

Terminal blocks are used as receiving, connecting, and distributing points for electrical circuits. Their construction is simple. They consist of a strip of insulation with screw type connections mounted on it. Little preventive maintenance is needed on the terminal blocks especially if the equipment has not been moved. The following paragraphs describe their care:

a. INSPECT (I). (1) Inspect the terminal blocks for cracks, breakage, dirt, and loose connections or mounting screws.

(2) Carefully examine the connections for mechanical defects, dirt, and corrosion.

b. TIGHTEN (T). Tighten loose screws, lugs, and mounting bolts. When tightening screws, be sure to select a screw driver of the correct size, and do not exert too much pressure. Remove loose connections and clean them when they are dirty or corroded.

c. CLEAN (C). Clean the terminal blocks, when they require it, with a dry brush. When necessary, use a cloth moistened with dry-cleaning fluid. If a solvent is used, the block must be thoroughly wiped with a cloth and then brushed to remove lint.

47. Jacks

Jacks require very little attention, and only at infrequent intervals. Occasionally it will be necessary to tighten the mounting nut, clean the contacts, or increase the spring tension. Remove dirt with a brush and dry-cleaning fluid, and remove corrosion with a piece of crocus cloth. Increase spring tension, when necessary, by grasping the spring near its point of attachment with a pair of long-nose pliers. Twist the pliers slightly in the direction in which tension is desired and move them continuously along the slight bow in the spring. The action of the jack should be tried after each adjustment. Be careful to keep all soldered connections intact.

48. Plug

a. INSPECT (I). Inspect the headset plug for dirt, rust, and corrosion.

b. CLEAN (C). Clean the plug with metal polish, using a clean, dry cloth. Do not apply an excessive amount of polish. Be sure to remove all of the residue of the polish after the

cleaning operation in order to maintain good electrical contact.

49. Capacitors

a. GENERAL. Before maintenance work is begun, it is absolutely necessary for the safety of personnel to *short-circuit all high-voltage capacitors* with a well-insulated screw driver.

b. INSPECT (I). (1) Inspect the terminals of the capacitors for corrosion and loose connections. The mountings should be carefully inspected for any loose mounting screws, studs, or brackets. Examine the leads for poor insulation, for cracks, and for evidence of dry rot. Cut away frayed strands on the insulation. If the wire is exposed, wrap it with friction tape. The terminals of the capacitors should not be cracked or broken.

(2) The case of each capacitor must be thoroughly inspected for breaks, bulges, and discoloration. Whenever a defective capacitor is found, it should be removed and replaced, if a replacement is available.

c. TIGHTEN (T). Tighten loose terminals, mountings, and connections on the capacitors.

d. CLEAN (C). Clean the case of the capacitor, the insulating bushings, and any connections that are dirty and corroded. The capacitor cases and bushings can usually be cleaned with a dry cloth, but if the deposit of dirt is difficult to remove, moisten the cloth in dry-cleaning solvent.

50. Resistors

a. INSPECT (I). Inspect the coating of vitreous resistors for signs of cracks and chipping, especially at the ends. Examine the bodies of all types of resistors for blistering, discoloration, and other indications of overheating. Also look for arc pits or craters. Inspect leads, the metallic ends of ferrule type resistors, and all other connections, for corrosion, dirt, dust, looseness, and broken strands in the connecting wires. Check the security of all mountings. Do not attempt to move resistors having pigtail connections because there is danger of breaking the connections at the point where they enter the body of the resistor. Such defects cannot be repaired.

b. TIGHTEN (T). Tighten resistor connections and mountings whenever they are loose. If a resistor is allowed to remain loose, vibration may break the connection or damage the body

c. CLEAN (C). (1) Clean all dirty or corroded connections on the resistors, using a cloth or brush dipped in dry-cleaning fluid. If the resistors are corroded, it will be necessary to sand them lightly with a fine grade of sandpaper and then wipe them clean with a dry cloth.

(2) The vitreous enameled resistor must be kept clean to avoid flash-overs or leakage between terminals. Ordinarily it may be wiped clean with a dry cloth; however, if the dirt deposit is unusually difficult to remove, use dry-cleaning fluid.

(3) Resistors with discolored bodies cannot be cleaned. Discoloration is indicative of overloading at some time prior to the inspection and is probably due to circuit trouble, which requires analysis.

51. Transformers and Filters

Almost without exception, transformers and filters must be replaced if defective, but preventive maintenance techniques give some amount of protection against failure at inopportune times.

a. FEEL (F). Feel wax-impregnated transformers for signs of overheating. The surest sign of overheating is the presence of insulating compound on the outside of the seams of the case. Overheating is an indication of circuit trouble and requires a system analysis.

b. INSPECT (I). Inspect transformers and filters for general cleanliness, and for tightness of connections, connecting lugs or terminals, mounting brackets, and rivets.

c. TIGHTEN (T). (1) Tighten loose mounting screws or connections *immediately.*

(2) If it is necessary to remove wires to tighten loose parts, note the position of the wires before they are unsoldered, and restore them to their original position.

d. CLEAN (C). (1) Clean the cases of the transformers and filters with a dry cloth. In a few instances, it may be desirable to use dry-cleaning fluid to remove foreign matter.

(2) Corroded contacts or connections can be sandpapered and wiped clean.

(3) Clean corrosion from ground connections and from resoldered connections.

52. Preventive Maintenance Tools and Materials

a. The following tools (components of Tool Equipment TE–49) and materials will be needed in performing preventive maintenance.

Screw driver TL–21.
Screw driver TL–44.
Soldering Iron TL–117.
Knife TL–29.
Pliers TL–126.
Wrench TL–111.
Wrench set (socket wrenches).
Tool, swbd, WECo No. 63 (socket wrench, triple end).
Tool, swbd, WECo No. KS–2348 (small screw driver).
Tool, swbd, WECo No. 417A (end wrench, 3/8 inch).
Soft bristle brush.
No. 0000 sandpaper.
Polish, metal paste, Federal spec No. P–P–556, type No. 111.
Crocus cloth.
Clean cloth.
Solvent, Dry Cleaning, Federal spec No. P–S–661a.
Petrolatum, U. S. Army spec No. 2–67A.

b. Make sure that all tools and materials required are on hand before starting preventive maintenance.

Section IX. PREVENTIVE MAINTENANCE CHECK LIST

53. Preventive Maintenance Check List

The following check list is a summary of the preventive maintenance to be performed on Repeater Set TC–18. The echelon column indicates which operations are first echelon maintenance and which operations are second echelon maintenance. Operations are indicated by the letters of the word FITCAL. For example, if the letters ITCA appear in the Operations column, the item to be treated must be inspected (I), tightened (T), cleaned (C), and adjusted (A).

54. Preventive Maintenance Check List for Repeater Set TC–18

Item No.	Operations	Item	When performed					Echelon
			Daily	Weekly	Monthly	Semi-annually	Yearly	
1	ITC	Repeater, exterior (par. 33)	X					1st
2	IC	Power cord (par. 34)		X				1st
3	IC	Fuses (par. 35)		X				1st
4	IC	Headset (par. 36)		X				1st
5	IT	Ground rods (par. 37)		X				1st
6	IT	Relays (par. 38)		X				2d
7	A	Meter (par. 39)		X				2d
8	ITC	Binding posts (par. 40)			X			1st
9	IC	Protectors (par. 41)			X			1st
10	ITC	Telegraph key (par. 42)			X			1st
11	IT	Wiring (par. 43)			X			2d
12	C	Relays (par. 38)			X			2d
13	IC	Keys and switches (par. 44)			X			2d
14	ITCAL	Potentiometers (par. 45)			X			2d
15	ITC	Terminal blocks (par. 46)			X			2d
16	ITC	Meter (par. 39)			X			2d
17	ITC	Jacks (par. 47)			X			2d
18	IC	Plug (par. 48)			X			2d
19	ITC	Capacitors (par. 49)				X		2d
20	ITC	Resistors (par. 50)				X		2d
21	FITC	Transformers and filter par. 51)				X		2d
22	A	Jacks (par. 47)					X	2d

F Feel — I Inspect — T Tighten — C Clean — A Adjust — L Lubricate

Section X. LUBRICATION

Note. A War Department lubrication order is not issued on Repeater Set TC–18 (Terminal, Telegraph). See paragraph 45, section VIII, Preventive Maintenance Techniques, for the lubrication instructions for this equipment.

Section XI. MOISTUREPROOFING AND FUNGIPROOFING

55. General

When operated in tropical areas where temperature and relative humidity are extremely high, Signal Corps equipment requires special attention. These are some of the problems met:

a. Resistors, capacitors, coils, chokes, transformer windings, etc., fail because of the effects of fungus growth and excessive moisture.

b. Electrolytic action, often visible in the form of corrosion, takes place in resistors, coils, chokes, transformer windings, etc., causing eventual break-down.

c. Hook-up wire insulation and cable insulation break-down. Fungus growth accelerates deterioration.

d. Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs and crosstalk.

56. Treatment

A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. See TB SIG 13 for a detailed description of the varnish-spray method of moistureproofing and fungiproofing and the supplies and equipment required in this treatment.

Caution: Varnish spray may have toxic effects if inhaled. To avoid inhaling spray, use respirator if available; otherwise fasten cheesecloth or other cloth material over nose and mouth. Never spray varnish or lacquer near an open flame. Do not smoke in a room where varnish or lacquer is being sprayed. The spray may be highly explosive.

57. Repeater TG–30 (Terminal, Telegraph)

a. PREPARATION. Make all repairs and adjustments necessary for proper operation of the equipment.

b. DISASSEMBLY. (1) With the carrying case open, remove the four large roundhead screws which hold the repeater in the carrying case, and lift out the repeater.

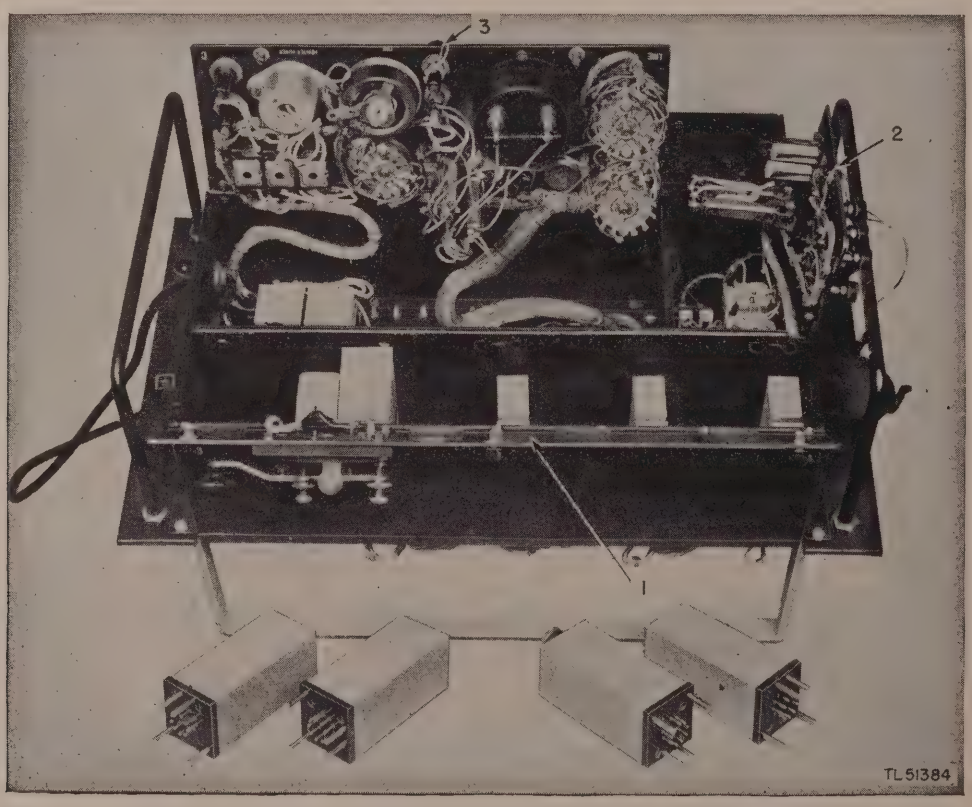


Figure 30. Repeater TG–30 (Terminal, Telegraph), prepared for moistureproofing and fungiproofing, top view.

(2) Loosen the three wing-head fasteners on the relay compartment cover and open the cover. (See fig. 30 (1).)

(3) Remove the four polar relays. These relays are not to be treated.

(4) Loosen the slotted-head fasteners hold-

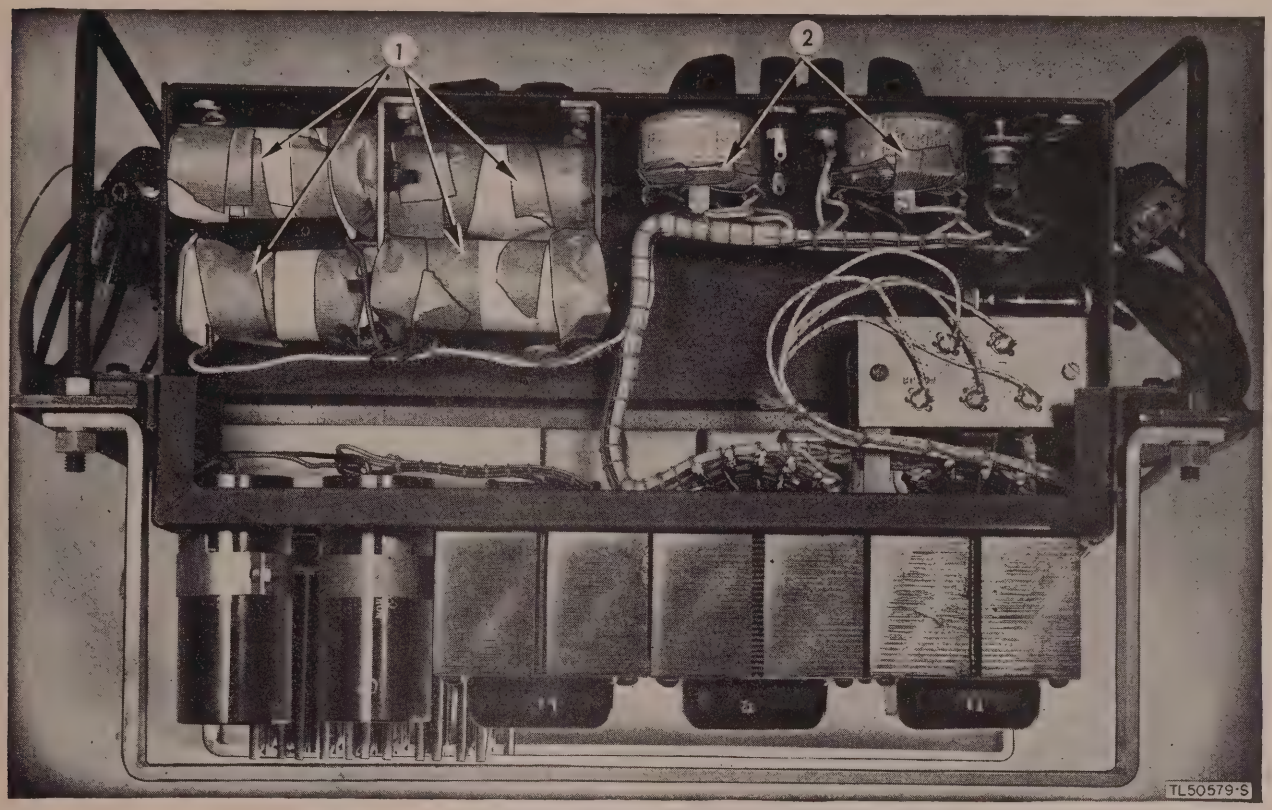


Figure 31. Repeater TG–30 (Terminal, Telegraph) prepared for moistureproofing and fungiproofing treatment, side view.

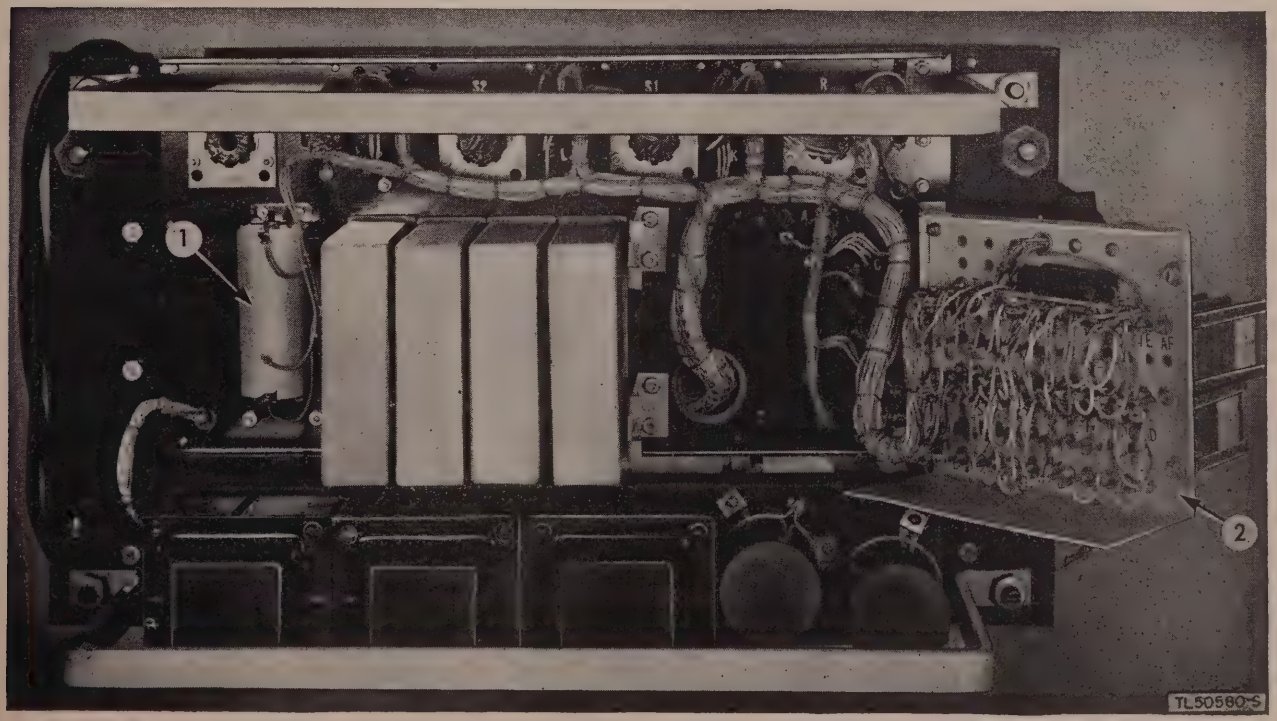


Figure 32. Repeater TG–30 (Terminal, Telegraph) prepared for moistureproofing and fungiproofing treatment, rear view.

ing the panel on which the six binding posts are mounted. Open and tie the panel so that it will stay open. (See fig. 30 (2).)

(5) Loosen the two slotted-head fasteners securing the meter panel. Open and tie the panel so that it will stay open. (See fig. 30 (3).)

(6) Loosen the two slotted-head fasteners securing the cover of the rectifier unit and remove the cover.

c. CLEANING. Clean all dirt, dust, rust, and fungus from the equipment to be processed. Clean all oil and grease from the surfaces to be varnished.

d. MASKING. (1) Mask the four selenium rectifier stacks mounted in the rectifier compartment. (See fig. 31 (1).)

(2) Mask the one selenium rectifier stack mounted underneath the chassis. (See fig. 32 (1).)

(3) Masking may be placed on the ADJUST VOLTS switches (fig. 31 (2)), the LINE switch, the LOCAL switch, and the ADJ CURRENT switch COARSE as a precautionary measure to avoid getting any of the lacquer on the contacts.

e. DRYING. Place equipment in oven or under heat lamps and dry for 2 or 3 hours at 160° F.

Caution: Do not exceed 160° F. Check temperature frequently and note appearance of waxes and insulating compounds on components. If wax or other insulating compound shows evidence of softening, reduce temperature and increase drying time I hour for each 10° F. drop in temperature.

f. VARNISHING UPPER SIDE OF CHASSIS. Apply three coats of moistureproofing varnish (Lacquer, Fungus-resistant, spec No. 71–2202 (stock No. 6G1005.3), or equal). Allow each coat to air-dry for 15 or 20 minutes before applying the next coat. The lacquer should be applied immediately after equipment is removed from oven. If this is not accomplished immediately, moisture will condense on equipment, thereby causing lacquer to dry over the moisture and peel off readily. The lacquer should be applied by brush to the following locations:

(1) Wiring and soldered connections above and below top panels including rectifier unit.

(2) Edge of phenolic base for telegraph key and edge of phenolic blocks on which the jacks are mounted.

(3) The following parts of milliammeter:

(*a*) Between glass and meter case.

(*b*) Between the zero adjusting screw and glass.

(*c*) At points where the terminals enter the back of case.

(*d*) Seam between the back and side of the case.

g. VARNISHING UNDER SIDE OF CHASSIS. (1) Close and fasten top panel covers and place repeater in upside down position.

(2) Loosen the two slotted-head fasteners and open the hinged resistance mounting plate. (See fig. 32 (2).)

(3) Apply brush coat to wiring and soldered connections on the under side of the chassis.

Caution: Polar type relays shall not be treated with a moistureproofing and fungiproofing lacquer or varnish. Care also should be taken to prevent varnish from getting into the contacts of the three rotary selector switches and on the disks of the two selenium rectifier stacks.

h. REASSEMBLY. (1) Remove all masking tape, being careful not to peel varnish from nearby areas.

(2) Install or replace gas adsorber units in each polar relay. Replace the relays only after the equipment is absolutely dry.

(3) Reassemble the repeater in reverse order of disassembly instructions and test its operation.

i. MARKING. Mark the letters MFP and the date of treatment near the nameplate.

Example: MFP—8 Jun 44.

58. Moistureproofing and Fungiproofing after Repairs

If, during repair, the coating of protective varnish has been punctured or broken, and if complete treatment is not needed to reseal the equipment, apply a brush coat to the affected part. Be sure the break is completely sealed.

PART FOUR

AUXILIARY EQUIPMENT

(NOT USED)

PART FIVE

REPAIR INSTRUCTIONS

Note. Failure or satisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on WD AGO Form 468; by Army Air Forces, on Army Air Forces Form 54. If either form is not available, prepare the data according to the sample form reproduced in figure 33.

Section XII. GENERAL REPAIR PROCEDURE

59. Repair Techniques

a. GENERAL. A complete knowledge of the detailed functions of the various parts and circuits in the equipment and trouble-locating procedures is necessary to perform satisfactory repairs. Keep service failures to a minimum by careful handling of the equipment during installation and operation, and by being careful when making field repairs and adjustments. Do not disturb the wiring any more than is necessary in testing or inspecting. If a soldering iron is used, do not drop splashes of solder on apparatus parts or wiring terminals.

b. WIRING DIAGRAM. A wiring diagram of the repeater circuit and the rectifier power circuit is shown in figure 59. In this diagram, each piece of apparatus has a letter designation corresponding to that shown on the wiring side; that is, the terminal side of each piece of apparatus. Each unit is shown in its relative location, as viewed from the wiring side. In this diagram, each piece of apparatus is arbitrarily assigned a number. Lines called feed lines, representing the individual wires, are carried a short distance and terminated on a common, or base line, turning at right angles to the feed lines. These feed lines are marked with the color of the wire and have a number near the base line which is the same as that of the piece of apparatus to which the other end of the wire is connected. It is not necessary to trace a connection through the common or base line and no provision is made for doing so. By observing the color and identification number, it is possible to trace directly to the other end of the wire. For example, by reference to J capacitor 76, a wire R134 is shown. This means a red wire is connected to 134. Resistor AD, which is 134, likewise indicates a red wire R76. Therefore, these are the two ends of the same wire, one end at capacitor J and the other end at resistor AD.

60. Unsatisfactory Equipment Report

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal, WD AGO Form 468 should be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form 54 should be filled out and forwarded through channels.

WAR DEPARTMENT
UNSATISFACTORY EQUIPMENT REPORT

FOR	TECHNICAL SERVICE: Signal Corps MATÉRIEL		DATE: 15 Dec. 44
FROM	ORGANIZATION: 579 Signal Repair Co.		STATION: APO 101 San Francisco, Calif
TO	NEXT SUPERIOR HEADQUARTERS: Signal Officer Ninth Army	STATION	TECHNICAL SERVICE

COMPLETE MAJOR ITEM

NOMENCLATURE: Repeater TG-30	TYPE: Terminal, Telegraph		MODEL
MANUFACTURER: Western Electric Company	U. S. A. REG. No.: 18266-Phila-44	SERIAL No.: 2289	DATE RECEIVED: 3 Nov. 44
EQUIPMENT WITH WHICH USED (if applicable)			

DEFECTIVE COMPONENT—DESCRIPTION AND CAUSE OF TROUBLE

PART No.	TYPE	MANUFACTURER	DATE INSTALLED
30B500-7	Capacitor (symbol C1)	P. R. Mallory and Co., Inc.	16 Nov. 44

DESCRIPTION OF FAILURE AND PROBABLE CAUSE (*If additional space is required, use back of form*)
Capacitor C1 shorts out due to humid operating conditions

DATE OF INITIAL TROUBLE	TOTAL TIME INSTALLED			TOTAL PERIOD OF OPERATION BEFORE FAILURE					
	YEARS	MONTHS	DAYS	YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
24 Nov. 44	0	0	8	—	—	—	60	—	—

BRIEF DESCRIPTION OF UNUSUAL SERVICE CONDITIONS AND ANY REMEDIAL ACTION TAKEN
Operating in tropics. Moisture proofed and fungiproofed, 8 Nov. 44

TRAINING OR SKILL OF USING PERSONNEL			RECOMMENDATIONS (*If additional space is required, use back of form*)
POOR	FAIR	GOOD ✓	Substitutions of capacitor designed for tropical operations

ORIGINATING OFFICER

TYPED NAME, GRADE, AND ORGANIZATION	SIGNATURE
E. A. WILSON, CAPT. SIG. C., 579 SIGNAL REPAIR CO.	E. A. Wilson

FIRST ENDORSEMENT

TO CHIEF	TECHNICAL SERVICE	OFFICE	
NAME, GRADE, AND STATION		STATION	DATE

Instructions

1. It is imperative that the chief of technical service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.
2. This form will be used for reporting manufacturing, design, or operational defects in matériel, petroleum fuels, lubricants, and preserving materials with a view to improving and correcting such defects, and for use in recommending modifications of matériel.
3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair or the issue of parts and equipment. It does not replace currently authorized operational or performance records.
4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (change No. 3).
5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches, or other illustrative material are highly desirable.
6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.
7. This form will be made out in triplicate by using or service organization. Two copies will be forwarded direct to the technical service; one copy will be forwarded through command channels.
8. Necessity for using this form will be determined by the using or service troops.

W. D., A. G. O. Form No. 468
30 August 1944

This form supersedes W. D., A. G. O. Form No. 468, 1 December 1943, which may be used until existing stocks are exhausted.

U. S. GOVERNMENT PRINTING OFFICE 16—41546-1

TL 50598-S

Figure 33. WD AGO Form 468 with sample entries.

Section XIII. DETAILED FUNCTIONING OF REPEATER TG–30 LINE CIRCUITS

61. Theory of Operation

a. GENERAL. The line side of Repeater TG–30 is arranged for either type B polarential or two-path polar operation. Hereafter, type B polarential operation will be referred to as polarential operation. Telegraph repeaters using the polarential, or two-path polar principle of transmission, do not require service adjustments to compensate for variations in the electrical characteristics of the line, due to changes in leakage resistance and grounded capacitance as a result of changing weather conditions. Two-path polar circuits require *two* independent telegraph channels between two repeater points, whereas polarential circuits require only *one* telegraph channel between two repeater points. A fundamental discussion of the two types of operation is given below.

b. POLARENTIAL OPERATION. Fundamentally, a circuit operating on a polarential basis uses polar transmission in one direction and differential transmission in the other direction. These two terms have been combined to form the word polarential. Figure 34 is a theoretical schematic of polarential operation.

(1) In a polar transmission system, the marking and spacing line currents are of the same magnitude but flow in opposite directions, hence, the receiving relay operates on reversals of line current and requires no local bias circuit.

(2) In a differential transmission sys-

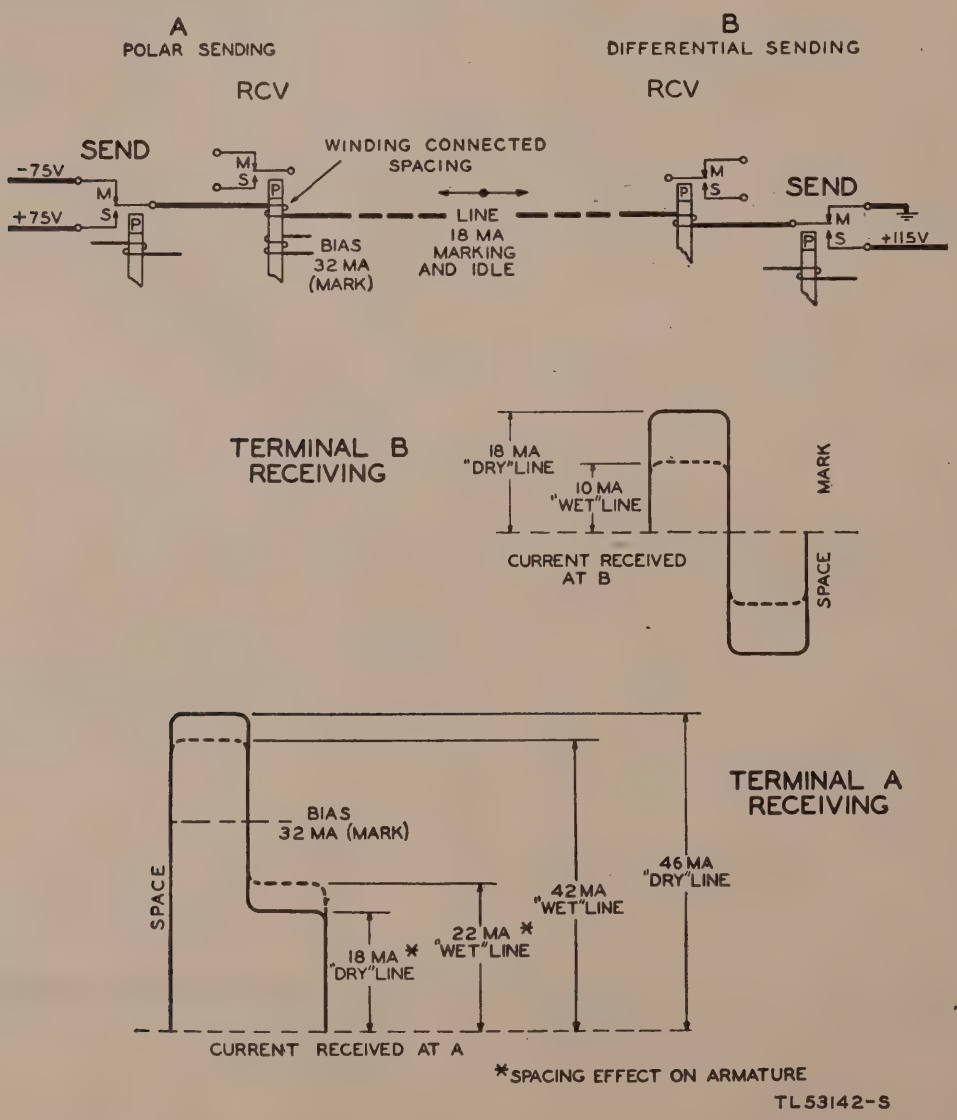


Figure 34. Theoretical schematic of polarential operation.

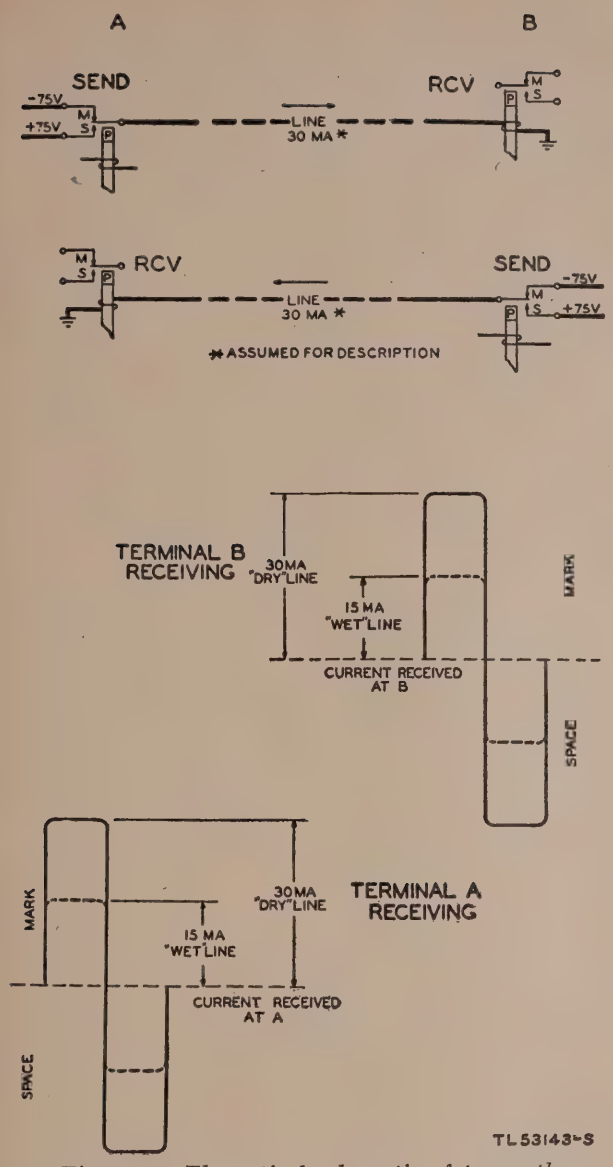


Figure 35. Theoretical schematic of two-path polar operation.

tem, the marking and spacing line currents are in the same direction, but differ in magnitude. This difference, as applied to the polarential method of operation, requires a spacing current in one direction of transmission about 2½ times the marking current. Since the spacing current is in the same direction as the marking current, a local biasing circuit is required on the receiving relay of the receiving repeater. The effect of this local biasing circuit is to hold the receiving relay on marking until the spacing line current is of sufficient value to overcome the effect of the biasing circuit and operate the receiving relay to space. By fixing this local biasing circuit in a marking direction at one-half the sum of the received marking and spacing line currents, and poling the line winding of the receiving relay spacing, the net effect on the armature of the receiving relay is equivalent to polar transmission. To get this equivalent of polar transmission in both directions on one telegraph channel, the opposite ends of a polarential circuit are made dissimilar regarding the connections of the sending and receiving relay circuits and the operating voltages applied to the line. One end of the circuit, known as the *polar-sending* end, applies negative and positive polarity of the same value while sending. The other end of the circuit applies ground for marking and positive polarity for spacing and is known as the *differential-sending* end of the circuit. The positive polarity at the differential-sending end is approximately twice the value of the negative or positive polarity applied at the polar-sending end.

(3) The theoretical schematic (fig. 34) represents a system in which the repeaters are equivalent to Repeater TG–30, except that the current assumed for the bias winding of the receiving relay at the polar-sending end is based on the assumption that equal currents in the biasing and line windings produce equal magnetic effects. In the polar relay used in Repeater TG–30 the actual turn ratio of the biasing winding to the line winding is three to one. This requires that the biasing current actually used in the relay be reduced to about one-third of the 32 milliamperes shown in figure 34.

c. Two-path Polar Operation. Two-path polar transmission utilizes one telegraph channel for signals transmitted from terminal A to terminal B, and another entirely independent telegraph channel for signals transmitted from terminal B to terminal A. A theoretical schematic of two-path polar operation is shown in figure 35. The circuit of the sending relay contacts and receiving relay windings at both ends of the line circuit are identical. A specific value of line current is not required since the receiving relay operates on reversals, but it should not be less than 10 milliamperes and not more than 30 milliamperes.

62. General Line Circuit Arrangements

The general arrangement of Repeater TG–30 and other equipment to provide telegraph circuits between two points is covered in paragraph 8. Each Repeater TG–30 contains arrangements for the three types of line operation

discussed in paragraph 61. In the case of polarential (polar-sending) and two-path polar operation, the transmitting branch of the repeater is arranged so that positive and negative battery may be applied to the line from a single nongrounded power supply. To obtain this type of transmitting arrangement with only a single power supply it is necessary to use two sending relays. Transmission from a repeater arranged for differential-sending uses only one of the relays for sending. The other relay holds the receiving relay on marking on outgoing signals. See figure 51 for winding and terminal arrangements of the polar relays. For polarential (polar-sending) and two-path polar operation the 115-volt power supply is reduced to 75 volts by the circuit consisting of series resistor AA and shunt resistor AB. (See fig. 37.) A detailed discussion of the various circuit elements used in line operation is given in the following paragraphs. For a detailed circuit schematic drawing see figure 58.

63. Adjust Line Current Circuit

Figure 36 is a schematic diagram of the adjust line current circuit and its connection to the line. The adjust line current circuit is connected in the line when the LINE switch is in position 1 or 3. The ADJ LINE CURRENT switch designated COARSE controls series resistances A, B, and C for an approximate adjustment of the line current. Capacitors A, B, and C are shunted across the series resistances to provide wave shaping. The final value of line current is obtained by turning the ADJ LINE CURRENT potentiometer (0–1250 ohms) designated FINE. The milliammeter indicates the value of the line current. The PROT BLOCKS serve to protect the equipment on line surges. FILTER A is a radio-suppression filter, and RET COIL A is a telephone noise-killing coil.

64. Line Side of Repeater Operating Polarential

Figure 37 shows in schematic form the line side of the repeater when it is arranged for polar-sending (LINE switch in position 1). Figure 38 shows in schematic form the line side of the repeater when it is arranged for differential-sending (LINE switch in position 2). These two figures represent the circuit arrangements of a system operating polarential. The opera-

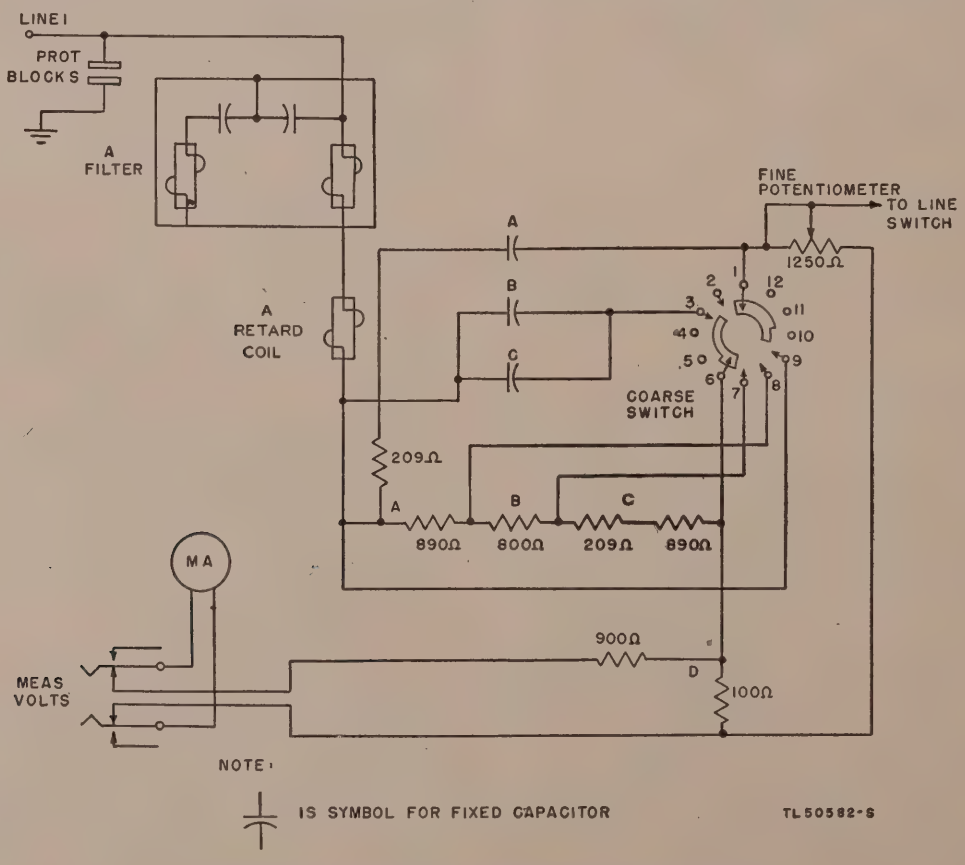


Figure 36. Schematic of adjust line current circuit.

tion of this system is covered in the following subparagraphs.

a. POLAR-SENDING FROM TERMINAL A (fig. 37) TO TERMINAL B (fig. 38). In the idle condition the sending relays S1 and S2 at terminal A are held on marking by the local circuit. The receiving relay R is held on marking due to approximately 10 milliamperes in the bias winding 9–8. Under these conditions terminal A is sending a mark to terminal B.

(1) When terminal A is sending a mark, the current flow in the circuits is from positive 115-volt battery at terminal A, through resistor AA, through contact M of relay S2 to ground, and through ground to the ground connection at terminal B. From the ground connection at terminal B the current flows through contact M of relay S1 and through winding 3–6 of relay R. Current in this direction through the line winding causes relay R to operate to mark. Operation of the receiving relay actuates the local circuit. The current flow continues through retard coil A, and filter A to LINE 1 binding post of terminal B, over the line to the LINE 1 binding post of terminal A, through filter A, retard coil A, the adjust line current circuit, winding 6–3 of relay R, and contact M of relay S1 to negative 115-volt battery.

(2) When the local circuit at terminal A operates the sending relays to space, the current flow is from positive 115-volt battery, through resistor AA, contact S of relay S1, winding 3–6 of relay R, the adjust line current circuit, retard coil A, filter A, the LINE 1 binding post, and over the line to the LINE 1 binding post of terminal B. At terminal B the current flows through filter A, retard coil A, and winding 6–3 of relay R. Relay R operates to space since the current flow is in the opposite direction from that for the marking condition. The circuit is completed through contact M of relay S1 to ground, through ground to terminal A, and through contact S of relay S2 to negative 115-volt battery.

(3) Discharge of the line capacity, especially on wet field wire circuits, tends to kick the receiving relay to spacing on outgoing signals. To prevent false operation during outgoing transmission, the receiving relay at terminal A is held on marking by an antikick circuit. Varistor A, in combination with capacitor E, and winding 7–2 of relay R form the antikick circuit. Resistor K terminates winding 7–2 of relay R in a suitable impedance and provides for the application of suitable voltages during marking and spacing impulses to insure proper functioning of the antikick circuit. Resistor E provides a load during a spacing impulse to aid in regulating the voltage output of the rectifier.

b. DIFFERENTIAL-SENDING FROM TERMINAL B (fig. 38) TO TERMINAL A (fig. 37). The line current is not adjustable at the repeater, which is operating differential-sending. In the idle condition the sending relays S1 and S2 are held on marking by the local circuit and the receiving relay is held on marking due to line current furnished from terminal A.

(1) When terminal B is sending a mark, the battery at terminal A is used as the power supply. Starting from positive 115-volt battery at terminal A the current flow in the circuit is through resistor AA, through contact M of relay S2 to ground, and through ground to ground connection at terminal B. From the ground connection at terminal B the current flows through contact M of relay S1, through winding 3–6 of relay R, retard coil A, filter A, the LINE 1 binding post of terminal B, over the line to the LINE 1 binding post of terminal A, and through filter A, retard coil A, the adjust line current circuit, winding 6–3 of relay R, and contact M of relay S1 to negative 115-volt battery. Relay R at terminal A holds on marking since the line current is not sufficient to overcome the effect of the local biasing circuit.

(2) When the local circuit at terminal B operates the sending relays to space, the current flow is from positive 115-volt battery at terminal B, through contact S of relay S1, winding 3–6 of relay R, retard coil A, filter A, the LINE 1 binding post, and over the line to the LINE 1 binding post of terminal A. At terminal A the current flow is through filter A, retard coil A, the adjust line current circuit, winding 6–3 of relay R, contact M of relay S1 to negative 115-volt battery. The circuit is then completed through the power supply of terminal A, resistor AA, contact M of relay S2, and ground to the ground connection at terminal B, which is connected to negative 115-volt battery. Since the power supplies of the two terminals are used in series for spacing, the line current increases from 18 milliamperes to 46 milliamperes on a dry line. This causes relay R at terminal A to operate to space by overcoming the effect of the current in the bias winding 8–9. As the effective bias current is approximately midway between the marking and spacing line currents,

incoming transmission affects the armature of the receiving relay equivalent to a reversal of line current. Operation of the receiving relay actuates the local circuit.

(3) Varistor A, in combination with capacitor E, resistor Y, and contacts of relay S2 constitute the antikick circuit at terminal B.

65. Line Side of Repeater Operating Two-path Polar

Figure 39 shows schematically the line side of the repeater when the LINE switch is in position 3. Signals are transmitted over the line connected from the LINE 1 binding post to the distant terminal LINE 2 binding post, and signals are received from the distant terminal over the line connected from the LINE 1 binding post at the distant terminal to the LINE 2 binding post at the local terminal. The line current is adjustable only in the sending line. In the idle condition, the receiving relay is held on marking by current flowing through line winding 3–6. When the sending relays S1 and S2 are actuated by the local circuit, negative 75 volts is applied to the line for marking and positive 75 volts for spacing. Varistor A, in combination with winding 2–7 of relay R and resistor N, provide a locking circuit to hold the receiving relay on marking when signals are being sent from the repeater. This holding circuit provides a communication break feature. Incoming signals from the distant terminal are current reversals of equal value. The magnitude of these current reversals is determined by the line current adjustment at the distant terminal.

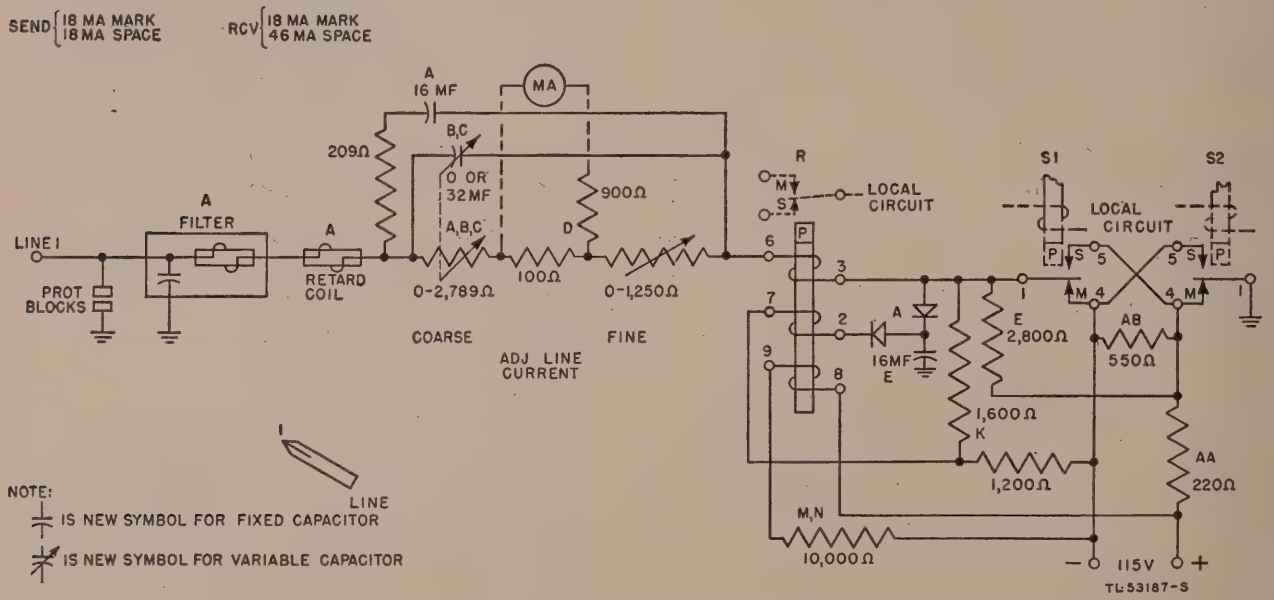


Figure 37. Schematic of line side of repeater operating polarential, polar-sending.

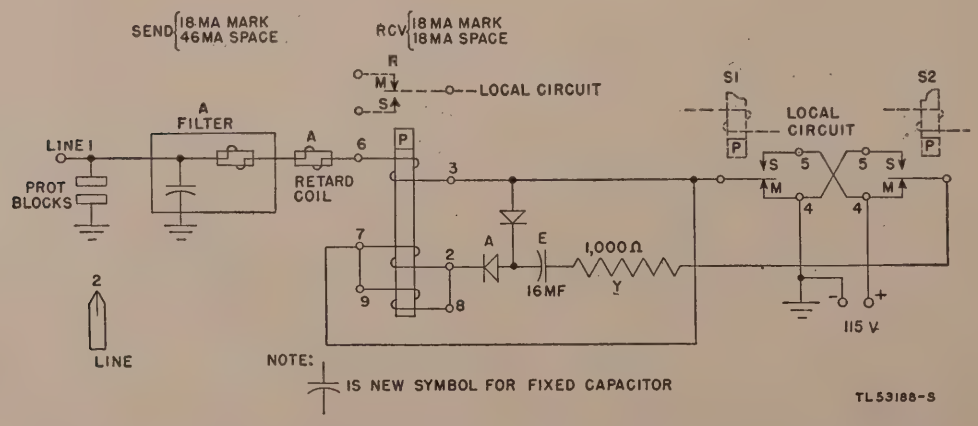


Figure 38. Schematic of line side of repeater operating polarential, differential-sending.

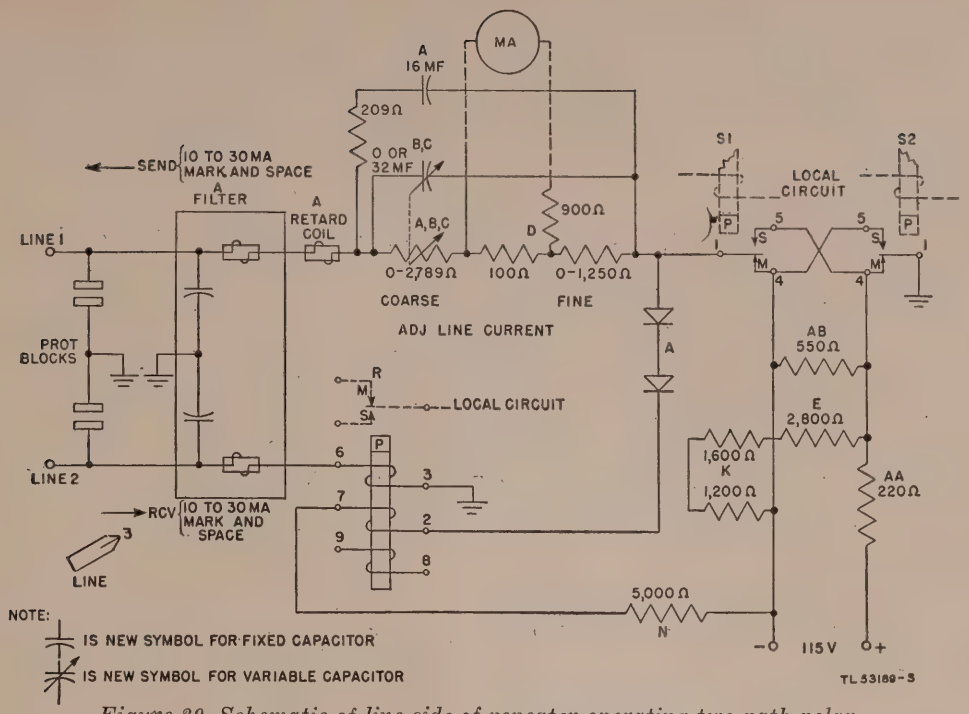


Figure 39. Schematic of line side of repeater operating two-path polar.

Section XIV.

DETAILED FUNCTIONING OF REPEATER TG–30 WITH LOCAL EQUIPMENT CIRCUITS

66. General

The local side of Repeater TG–30 is arranged for connections to teletypewriters with separate sending and receiving circuits, to 30- or 60-milliampere neutral loops, and for intermediate operation with another Repeater TG–30. The general arrangements of the repeater operating with local equipment is covered in paragraphs 9, 10, and 11. For descriptive purposes in this section, polarential (polar-sending) line operation has been shown schematically with local circuit arrangements. Detailed functioning of the repeater with the various local circuits is covered in the following paragraphs.

67. Local Operation with Teletypewriter TG–7–B

Figure 40 is a complete functional schematic showing the repeater and rectifier power supply with the line side of the repeater arranged for polarential (polar-sending) and the local side connected to a teletypewriter (LOCAL switch in position 1). Figure 41 shows schematically the local side of the repeater when the LOCAL switch is in position 1. All + and — signs represent connections to the repeater power supply. When idle, the sending relays S1 and S2 are held marking due to about 30 milliamperes in windings 3–6, and the teletypewriter selector magnet is held operated by a current of about 70 milliamperes. Operation of the sending contacts of the teletypewriter opens the selector magnet circuit to produce local copy. The line windings 3–6 of the sending relays are also opened by the teletypewriter sending contacts, and these relays are operated to space, due to current through bias windings 9–8. On incoming signals, the receiving relay R removes negative 115 volts from the selector magnet circuit, thereby causing the selector magnet of the teletypewriter to function. The sending relays are held marking when the receiving relay is spacing due to the application of negative 115 volts via current limiting resistor Z and windings 2–7. This hold circuit provides a communication break feature. Resistor T and resistors P, R, and S limit the current to the required value for windings 3–6 and windings 9–8 respectively. Resistors AE and AF, shunted by capacitor P, limit the cur-

rent required for the selector magnet and provide wave shaping. Resistor AC and capacitor L (fig. 40) form a spark killing circuit for the sending contacts of the teletypewriter.

This current is furnished from the negative 115-volt supply used in connection with the switchboard. The local current is adjusted to 60 milliamperes by a line rheostat in the switchboard. This 60-milliampere current divides almost equally between resistors H and L, thereby providing a current of about 30 milliamperes through windings 3–6 of the sending relays. When switchboard local relay EAST is released, current is removed from line windings 3–6 of relays S1 and S2, and these relays are operated to space due to current through bias windings 9–8 when windings 3–6 are

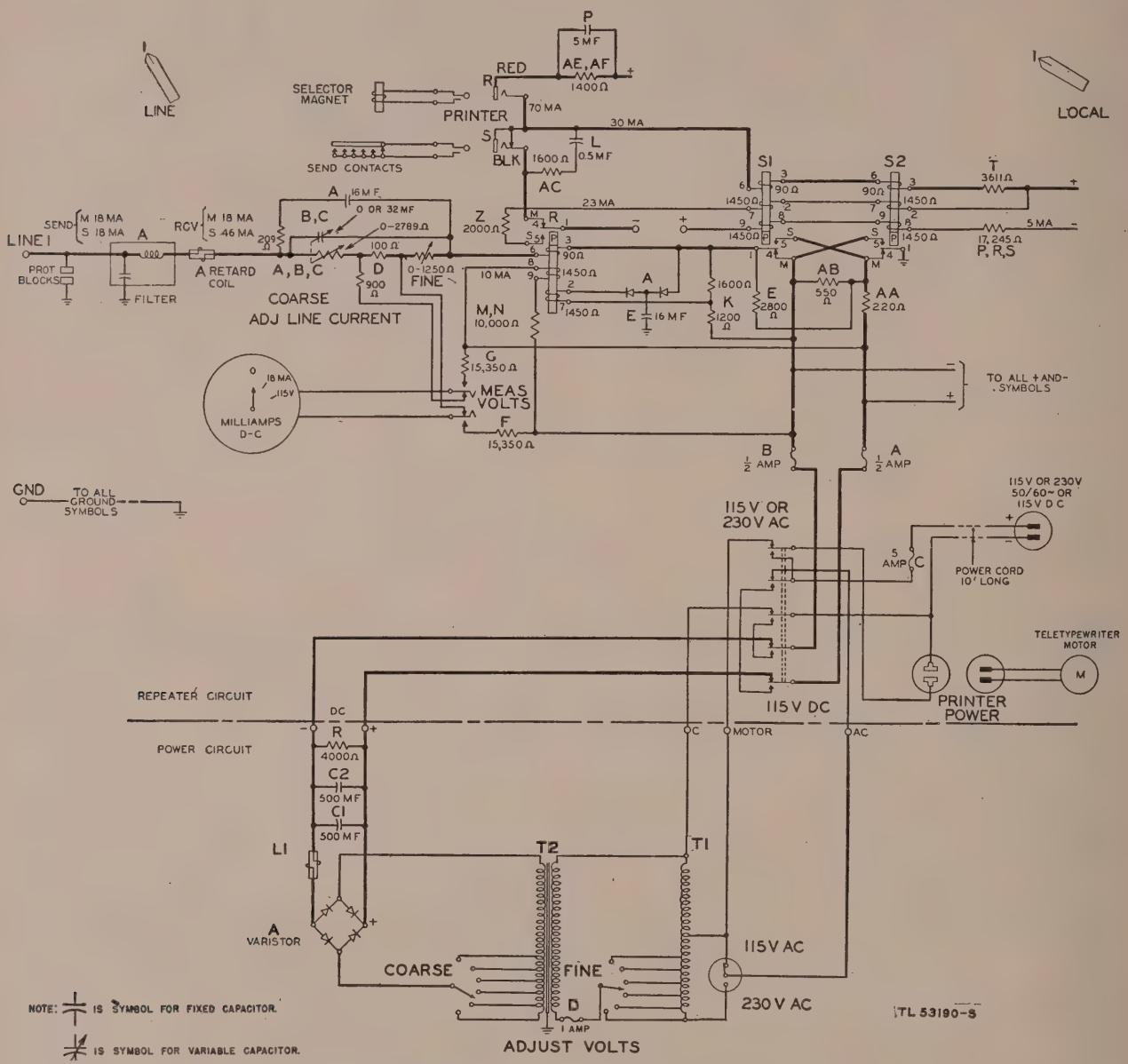


Figure 40. Functional schematic of repeater and power circuit, teletypewriter connected to Repeater TG–30.

68. Local Operation with Switchboard BD–100

Figure 42 shows schematically the local circuit of the repeater when the LOCAL switch is in position 2 and when LOCAL binding post 1 is connected to a LINE terminal in Switchboard BD–100. In the idle condition, the sending relays S1 and S2 are held marking by approximately 30 milliamperes through windings 3–6.

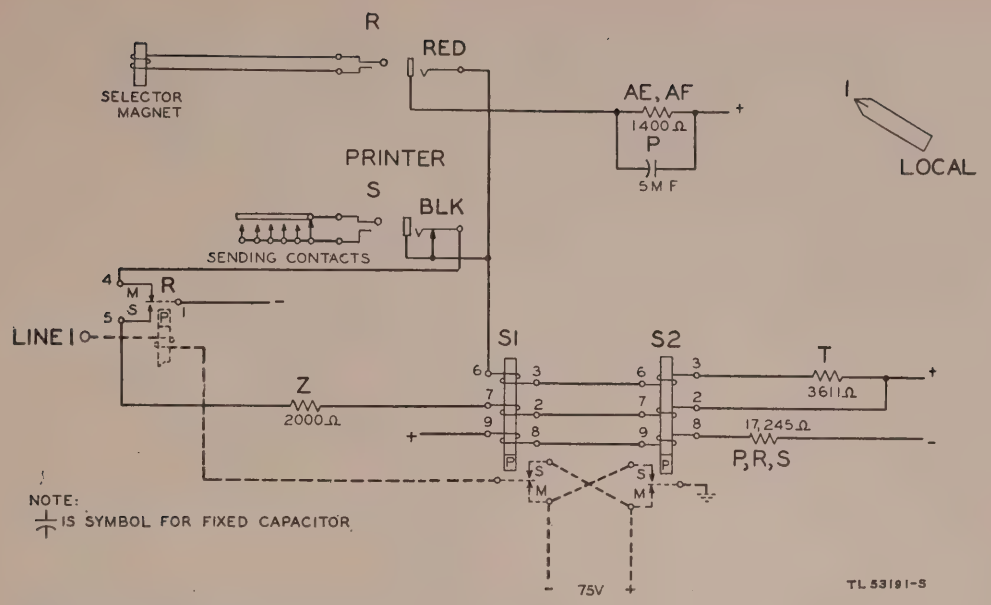


Figure 41. Schematic of local side of repeater operating with Teletypewriter TG–7–B.

opened. On incoming signals, the receiving relay R removes ground from the local circuit and opens the circuit to the switchboard, thereby causing the release of line relay WEST. Windings 2–7 of relays S1 and S2 with resistor Z provide a circuit to hold the sending relays on marking when spacing signals are received by relay R. Relay windings 9–8, in combination with resistors P, R, and S, provide the local bias circuit.

69. Local Operation with Line Unit BE–77–(*)

Figure 43 shows schematically local circuit operation with the LOCAL switch in position 2 and LOCAL binding post 1 connected to the LINE terminal of a Line Unit BE–77–(*). The operating features and local current adjustments are identical to operation with Switchboard BD–100. (See par. 68.) The relay in the line unit responds to incoming signals repeated by receiving relay R, and the sending contacts of the teletypewriter connected to the line unit opens and closes the windings 3–6 of the sending relays S1 and S2, which transmit to the line circuit.

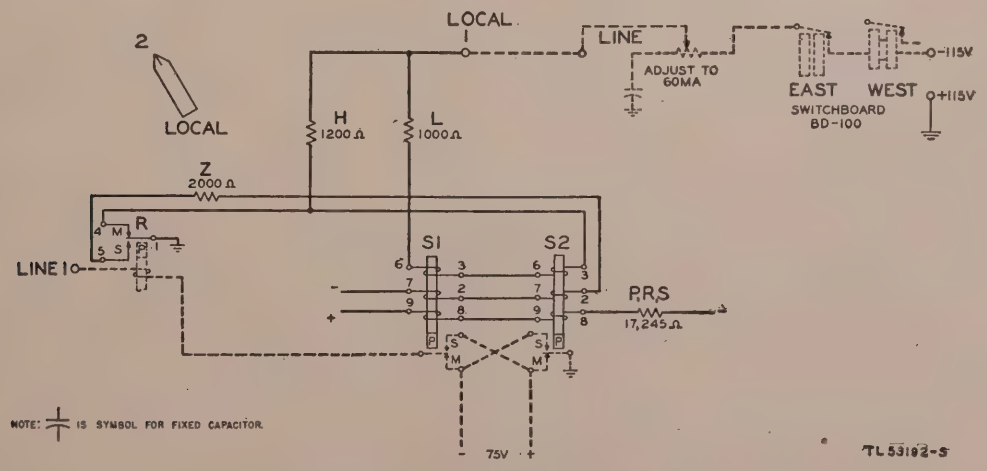


Figure 42. Schematic of repeater operating with Switchboard BD–100.

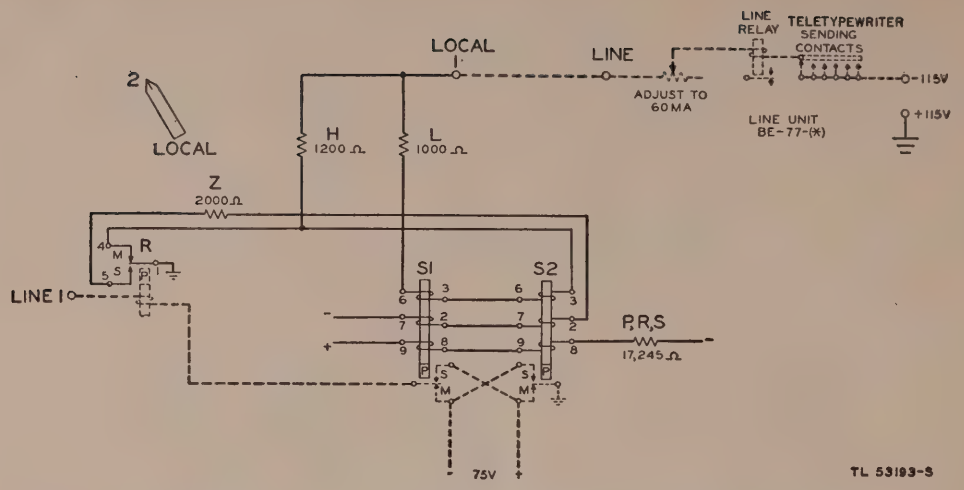


Figure 43. Schematic of local side of repeater operating with Line Unit BE–77–(*).

70. Local Operation with a Teletypewriter Equipped with a Line Relay

Figure 44 shows schematically the local side of the repeater connected to a station in which the teletypewriter is equipped with a line relay with a 30-milliampere bias current. The teletypewriter station should have an adjustable resistance (0–2,000 ohms) added in series in the line to permit a line current adjustment to 60 milliamperes. Operation of the receiving relay in the Repeater TG–30 opens and closes the station line; the bias current (30 milliamperes) in the line relay in the station causes its operation to spacing when the line is open. The line relay actuates the teletypewriter selector magnet. Sending from the teletypewriter opens and closes the line and causes operation of relays S1 and S2 (3–6 windings) which transmit from Repeater TG–30. The teletypewriter line relay responds to outgoing signals to produce local copy.

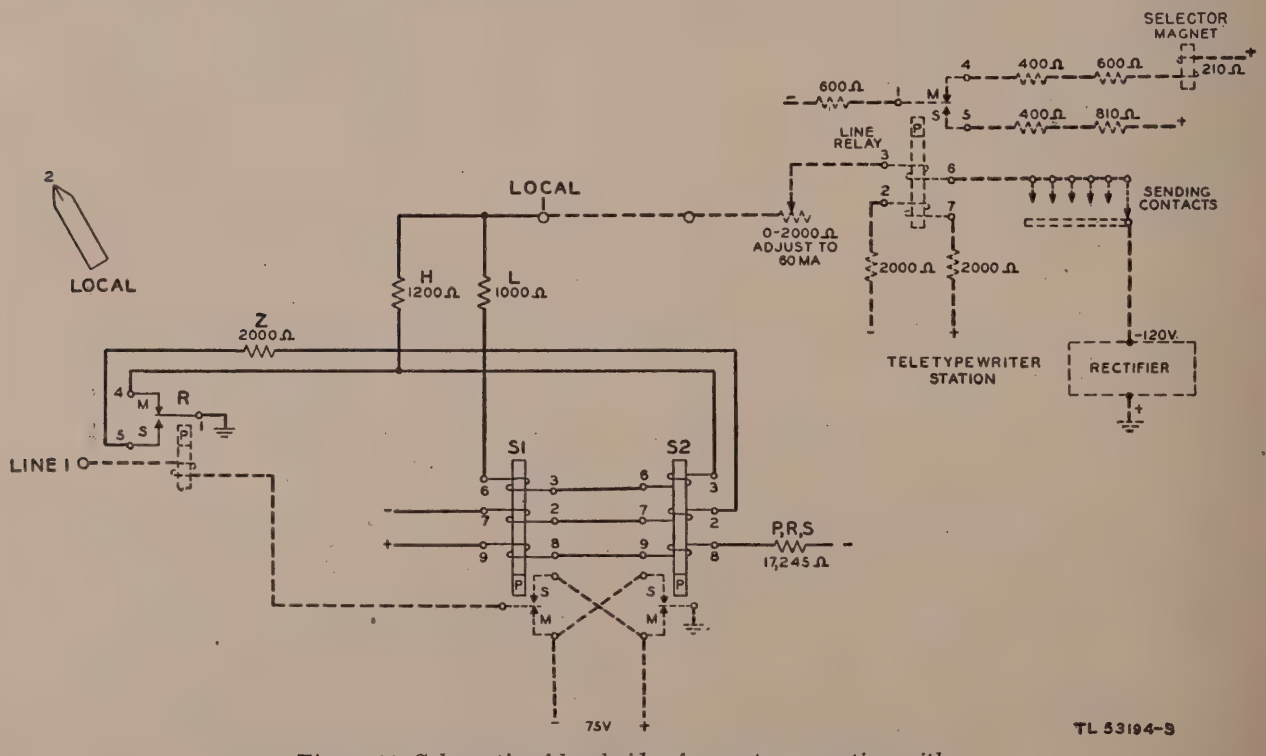


Figure 44. Schematic of local side of repeater operating with a teletypewriter equipped with a line relay.

71. Local Operation with a Carrier Telegraph Terminal

a. Figure 45 is a schematic of the local circuit of the repeater with the LOCAL switch in position 3 and wires connected from LOCAL binding posts 1 and 2 to SL and RL (T SEND and T REC for Carrier Terminal OA–4/FC or OA–5/FC) binding posts of a channel in a carrier telegraph terminal. (See par. 8*c*(2) for nomenclature.) The LOOP switch in the carrier equipment is turned to NEUTRAL TO NEG BAT — HALF DX. The local current is adjusted to 60 milliamperes by the potentiometer in the carrier equipment, and the current is indicated by a meter in the carrier terminal.

Note. Telegraph Terminal TH–1/TCC–1 does not use a BK relay in its local circuit. The functioning of the remainder of the circuit is the same as described in the following subparagraphs.

b. In the idle condition, the 60-milliampere local current flows from positive 130 volts at contact M of REC relay, through the SEND and BK relays in the carrier equipment, binding posts SL and LOCAL 1, windings 3–6 of relays S1 and S2, marking contact of relay R, and binding posts LOCAL 2 and RL to negative 130 volts in the carrier equipment. The 60-milliampere current through the line winding of the SEND and BK relays holds these relays to their M contacts. A current of approximately 30 milliamperes flows in the artificial line windings of the SEND and BK relays in a direction to operate these relays to their S contacts. Since the current in the line windings is twice as great as the current in the artificial line windings, the relays are held operated to mark.

c. Operation of relay REC in the carrier equipment to space connects negative battery to windings 3–6 of relays S1 and S2 in Repeater TG–30, removing the 60-milliampere current through these windings. Current in windings 9–8 of relays S1 and S2 causes them to operate to space, and a spacing signal is sent to the distant repeater. The current in the artificial line windings of the BK and SEND relays in the carrier equipment reverses direction and is of sufficient value to hold these relays to their M contacts.

d. On an incoming space signal to the telegraph repeater, the receiving relay R opens the circuit through the line windings of the SEND and BK relays and the current in the artificial line windings operates them to space, with the result that a spacing signal is sent to the distant carrier terminal. The sending relays S1 and S2 are held marking on an incoming space due to the application of negative 130 volts in the carrier equipment via spacing contact of relay R, resistor Z, and windings 2–7 of the sending relays S1 and S2. Resistor S, in combination with windings 8–9 of the sending relays, provides a local bias current of about 10 milliamperes.

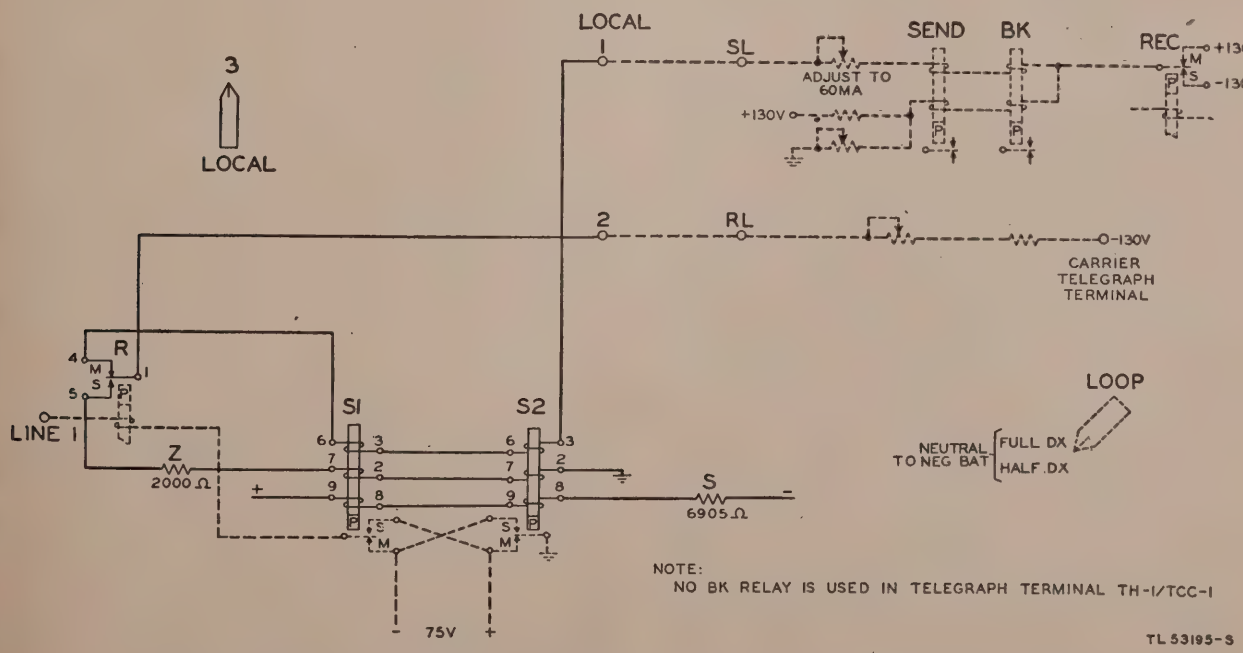


Figure 45. Schematic of local side of repeater operating with a carrier telegraph terminal.

72. Local Operation Using Two Repeaters TG–30 to Provide Intermediate Operation

a. Figure 46 shows schematically the local circuits of two Repeaters TG–30 arranged to provide intermediate operation with or without a teletypewriter. The LOCAL switch of the repeater to which the teletypewriter is connected *must be* in position 4, and the LOCAL switch of the other repeater *must be* in position 5. The LOCAL binding posts 1, 2, and 3 of one repeater are connected to binding posts 1, 2, and 3, respectively, of the other repeater. These connections provide the proper local circuit current, therefore no local current adjustments are required. In the following description, the repeater connected to the line to distant terminal A will be called repeater A and the one connected to the line to distant terminal B will be called repeater B. The local circuit-closed condition includes the marking contact of relay R in repeater B, LOCAL binding posts 2, the marking contact of relay R in repeater A, the sending contacts of the teletypewriter, windings 3–6 of relays S1 and S2 in repeater A, resistors W and L in repeater A, LOCAL binding posts 1, resistors W and L in repeater B, and windings 3–6 of relays S1 and S2 in repeater B. This produces a local current of about 30 milliamperes. The sending relays of each repeater have a local bias current of about 5 milliamperes flowing through windings 8–9 and resistors J, P, R, and S. This 5-milliampere current is equivalent to a 15-milliampere current in a 90-ohm winding.

b. When terminal A is transmitting a space to terminal B, the receiving relay R, repeater A, opens the local circuit and causes operation of relays S1 and S2 in repeater B, which retransmit to the line to terminal B. Relays S1 and S2 in repeater A are held marking by the circuit consisting of LOCAL binding posts 3, windings 2–7 of relays S1 and S2 in repeater A, resistor Z, spacing contact of relay R in repeater A, LOCAL binding posts 2, and marking contact of relay R in repeater B. The receiving relay R, repeater A, responding to the incoming transmission also operates the selector magnet of the teletypewriter due to removal of the negative 115 volts applied at the armature of receiving relay in repeater B. This provides a copy at the intermediate point. The selector magnet closed circuit involves the marking contact of relay R in repeater B, LOCAL binding posts 2, marking contact relay R in repeater A, sending contacts of teletypewriter, selector magnet, resistors AE and AF, and LOCAL binding posts 3.

c. When terminal B transmits a space to terminal A, the receiving relay R, in repeater B, operates and opens the local circuit, and causes operation of the relays S1 and S2 in repeater A, and the selector magnet. Relays S1 and S2, repeater B, are held marking by the current through the spacing contact of relay R in repeater B, resistor Z, and windings 2–7 of relays S1 and S2 in repeater B.

d. Sending from the teletypewriter opens and closes the local circuit which causes operation of sending relays S1 and S2 in both repeaters, but does not cause operation of either receiving relay. Relays S1 and S2 send to their associated line circuits; that is, sending is simultaneous to terminals A and B. The sending contacts of the teletypewriter also control the selector magnet circuit to produce local copy.

73. Manual Telegraph Set Operation

Figure 47 is a schematic of the manual telegraph set which is a part of Repeater TG–30. The manual telegraph circuit uses the sending and receiving features of the repeater. It becomes operative when the LOCAL switch is in position 1, the teletypewriter cords are removed, and the headset cord is connected to the headset jack. The telegraph key is connected in the circuit when the teletypewriter sending cord is removed. Sending is from the back contact of the telegraph key, with the signal (tone heard in headset) occurring when the key is held down. This tone results from the oscillator circuit consisting of a small neon lamp, TONE, capacitor M, resistor AG, and a 1-megohm potentiometer, ADJ TONE, in combination with the receiver. The oscillating frequency may be varied over a wide range by adjusting the ADJ TONE potentiometer. In the idle condition, the negative side of the power supply is applied to both sides of the circuit, at the marking contacts of relay S1 and the marking contact of relay R, and no oscillations occur. When the telegraph key is operated the sending relays S1 and S2 operate to space, and the positive and negative sides of the power supply are applied to the circuit. The tube oscillates, thereby producing a tone in the receiver. When the receiving relay responds to incoming line signals, the negative side of the 115-volt supply is removed from contact M of relay R and the tube oscil-

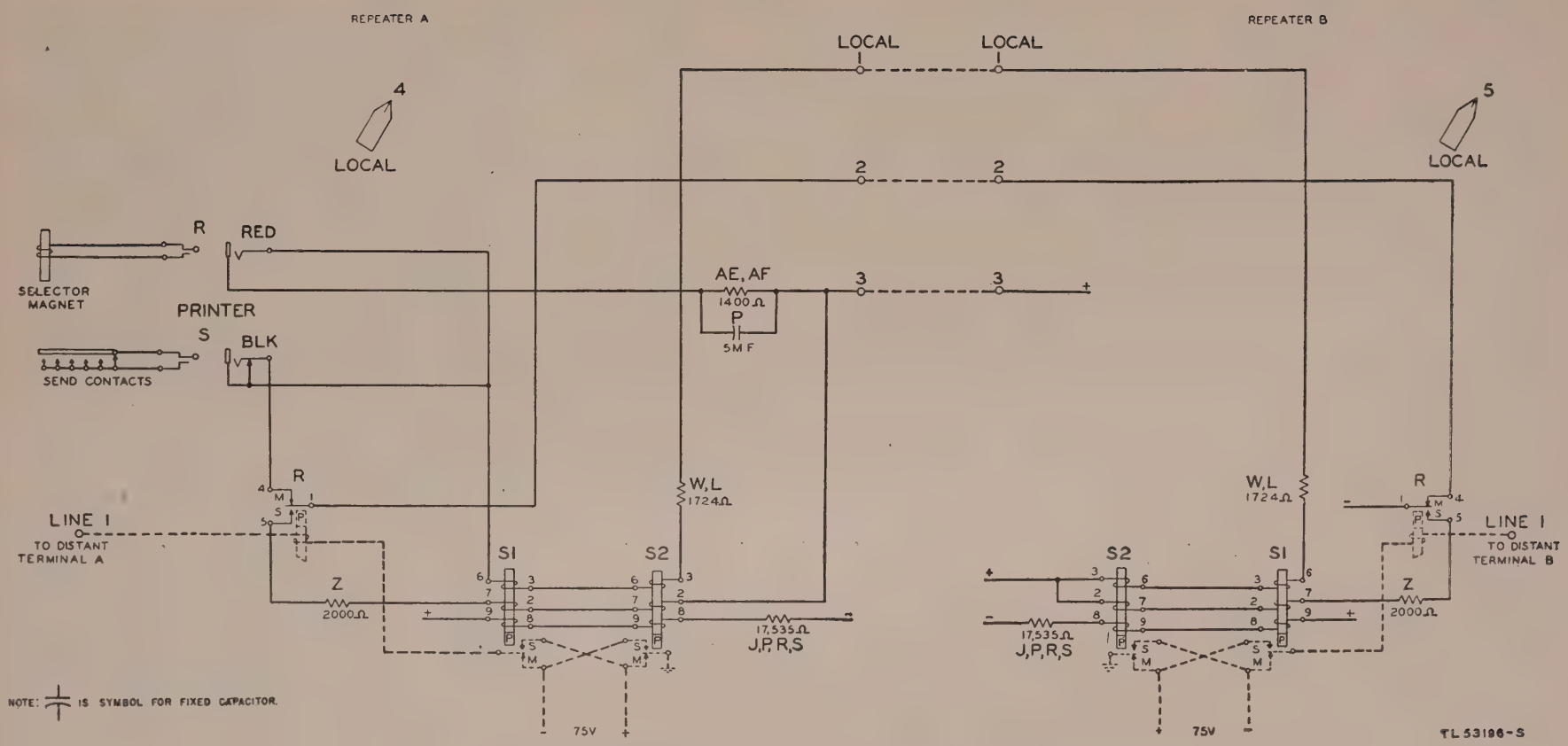


Figure 46. Schematic of local circuits of two Repeaters TG–30 providing intermediate operation with a teletypewriter.

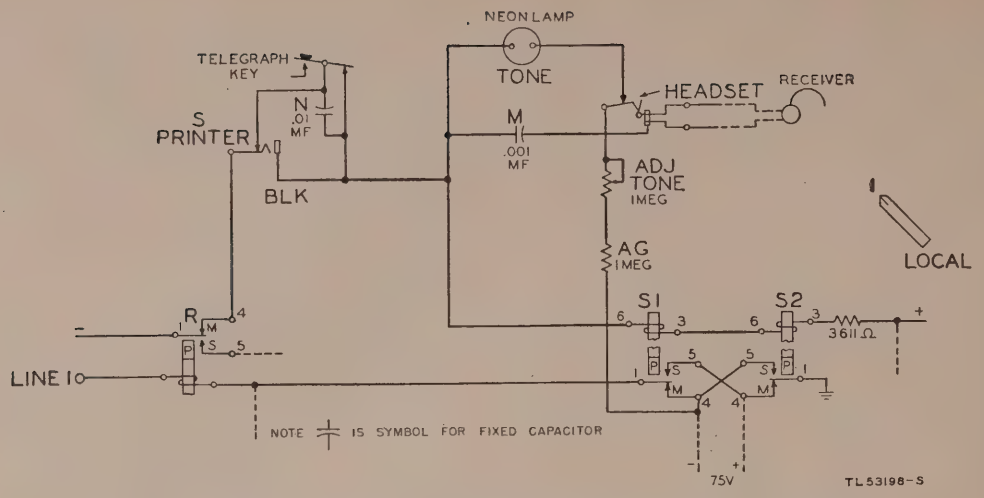


Figure 47. Schematic of manual telegraph set (part of Repeater TG–30).

lates due to application of the positive and negative sides of the power supply.

74. Rectifier Power Circuit Operation

The rectifier power circuit is shown schematically as part of figure 40 and in detail in figure 48. The voltage applied to the autotransformer T1 is controlled by the 115V AC—230V AC switch. In the 115V AC position, the power-supply voltage is applied to the lower portion of the winding and in the 230V AC position the power-supply voltage is applied to the total winding. In both cases, the voltage applied to the primary of the transformer T2 is adjusted by operating a multiple contact switch which selects *fine* taps on the autotransformer. The secondary of transformer T2 is supplied with *coarse* taps, which are controlled by a multiple contact switch. By turning the FINE and COARSE switches designated ADJUST VOLTS, the voltage applied to varistor A is adjusted to provide an output of 115 volts dc. The midpoint tap on the autotransformer provides 115 volts ac for the teletypewriter motor when the power supply is 230 volts ac. The selenium disk rectifier (varistor A) is a full-wave rectifier which converts alternating current to direct current. Retardation coil L1 and capacitors C1 and C2 serve as a filter to reduce the ripple. The resistor R is an artificial load and aids in producing the required voltage regulation characteristics.

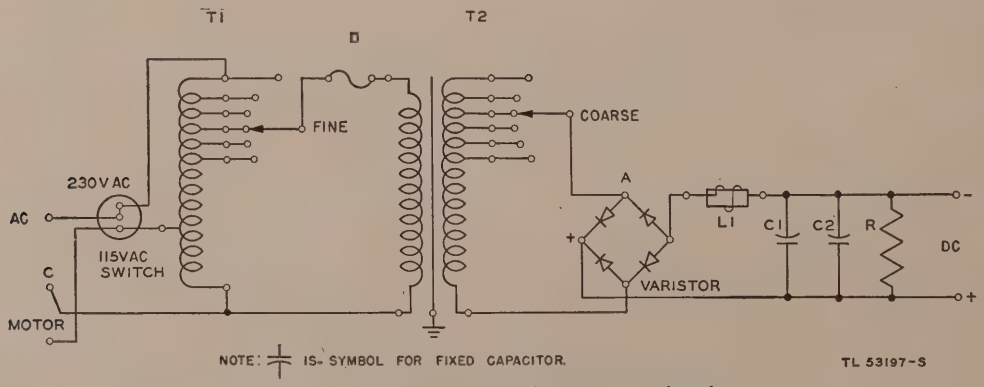


Figure 48. Schematic, rectifier power circuit.

Section XV. TROUBLE LOCATION

75. General Trouble-Locating Information

No matter how well equipment is manufactured, faults will develop in service. When such faults occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble locating.

a. TROUBLE-LOCATING DATA. Take advantage

of the material contained in this manual to help in the rapid location of faults. Consult the following data when necessary.

(1) Complete schematic diagram. (See fig. 58.)

(2) Schematics of line side of repeater. (See figs. 36 to 39.)

(3) Schematics of operation with local equipment. (See figs. 40 to 47.)

(4) Wiring of circuits, circuit label. (See fig. 59.)

(5) Illustrations of components. (See figs. 51 to 55.)

b. TROUBLE-LOCATING STEPS. The first step in servicing a defective repeater is to sectionalize the fault. Sectionalization means tracing the fault to the component or circuit responsible for the trouble in the repeater. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the trouble. Some faults such as burned-out resistors and shorted transformers can be located by sight and smell. The majority of faults, however, must be located by checking voltage and resistance.

76. Test Equipment

Two items of test equipment are needed for test and maintenance of Repeater TG–30.

a. VOLTOHMMETER. A voltohmmeter is required for measuring a-c or d-c voltages, the resistance of resistors, and to check capacitors for short circuits or grounds. For this purpose use Voltohmmeter I–166 or any other available voltohmmeter having an internal resistance of at least 1,000 ohms per volt.

b. TEST SET I–193–A. This test set is used for testing the polar relays used in the repeater. The rectifier power unit in Repeater TG–30 may be used as a source of d-c power for operation of Test Set I–193–A when the power source available is alternating current. A cord equipped with a gray-colored shell is supplied with the test set for patching to the battery supply TEST SET jack in Repeater TG–30. Connect the tip (white) conductor of the cord to + BAT, the ring (blue) conductor to — BAT, and the sleeve (red) conductor to GND binding post on the test set. Operate the LINE switch of Repeater TG–30 to position 2 in order to ground the negative side of the repeater power unit and operate the LOCAL switch to position 1. Connect ground to the GND binding post of the repeater and operate the power switches as covered in paragraph 22. Adjust the voltage to 115 volts by turning the ADJ VOLTS knobs COARSE and FINE. Any or all of the relays may be removed from the repeater

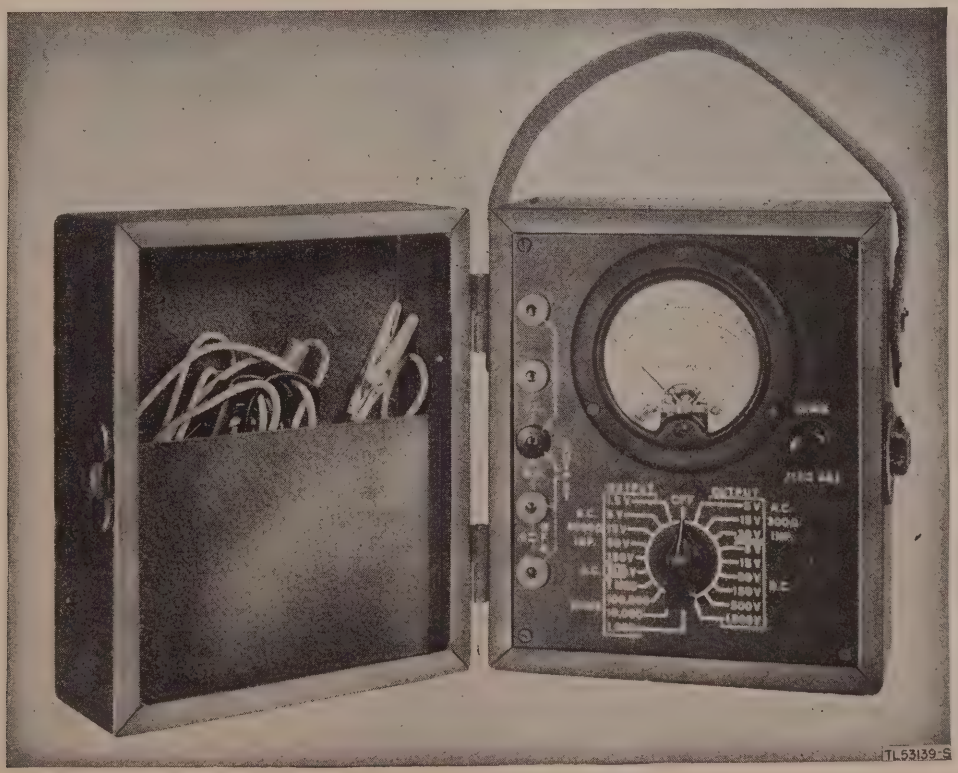


Figure 49. Voltohmmeter I–166.

Figure 50. Test Set I–193–A.

while it is supplying power for operating the test set. See TM 11–2513 for detailed information on testing and adjusting the polar relays.

77. Trouble-Locating Procedures

The accompanying trouble-locating charts, if properly used, simplify trouble location. Three charts are included.

a. The operator's trouble-locating chart (par. 78) covers sectionalization of trouble in the repeater. This chart lists the various symptoms which may be recognized easily by the operator, and gives the probable location for the existing trouble as well as the recommended correction. The corrections listed are those which the operator can make, and which do not require removing the repeater from the carrying case.

b. The repairman's trouble-locating chart (par. 80) covers troubles which the operator may be able to localize, but the correction of which requires removing the repeater from the carrying case.

c. The third chart (par. 81) consists of normal voltage and resistance measurements of the circuit components. As abnormal resistance and voltage measurements are an indication of trouble at the particular point, this chart will be of assistance to the repairman in locating trouble.

78. Operator's Trouble-Locating Chart

Symptom	Probable trouble	Correction
No line current with LINE switch in position 1 or position 3.	Line open or distant terminal not connected and supplying ground.	Check with distant terminal on its connections. Use another line if necessary.
	Connections broken at binding posts.	Repair connections.
	Local power has failed.	Check local power source.
Meter indicates high line current approximately 45 milliamperes to right of zero with LINE switch in position 1.	Spacing line current due to local circuit being open at distant terminal.	Close local circuit at distant terminal.
Low line current.	Distant terminal not connected and leakage present on line wire.	Connect on distant terminal. Use another line if necessary.
	Poor line connections.	Repair line connections.
	Low power-supply voltage.	Raise voltage of power supply.
	High ground resistance.	Improve ground.
Meter indicates line current steady to left of zero and equal to normal marking line current. LINE switch in position 1 or 3.	Space is being sent locally.	Check local equipment for proper operation.
	Local circuit is open and sending relays are spacing.	Close local circuit.
	D-c power supply reversed.	Reserve power cord.
Erratic line current.	Loose line connections at distant terminal or at local repeater.	Repair line connections at repeaters.
Errors on printed copy at teletypewriter on incoming signals.	Incorrect voltage or current adjustment locally or at distant terminal.	Check voltages and adjustment of current.
	Loose connections.	Check connections.
	Receiving relay out of adjustment.	Replace relay.
Errors on printed copy at teletypewriter when sending locally.	Receiving relay out of adjustment and "kicking-off" on outgoing signals.	Replace relay.
	Sending relays out of adjustment.	Replace relays.
No d-c voltage output.	Main fuse C (5 amp) or power circuit fuse D (1 amp) or positive or negative fuses A or B (+½ amp or —½ amp) blown.	Check and replace blown fuses.
	Failure of power supply.	Check power supply.
	Poor connection in power cord.	Repair power cord.
Low d-c output voltage.	Low a-c voltage.	Check a-c voltage.
	115V–230V switch in power unit may be on 230V position when input is 115 volts a-c.	Throw switch to 115V AC position.
High d-c output voltage.	High a-c voltage.	Check a-c voltage.
No tone in headset when telegraph key is held down (manual telegraph operation).	Neon lamp (TONE) is burned out.	Replace neon lamp.

79. Trouble Location With Repeater out of Service

a. If the repeater cannot be made to work properly by the procedure covered in the operator's trouble-locating chart (par. 78), it will be necessary to remove the repeater from service and test for trouble.

b. In locating an unknown trouble the use of another Repeater TG–30 known to be in good condition will be useful. The two repeaters may be set up with a dummy line consisting of a resistance of 500 ohms. Two dummy lines are required for two-path polar operation. These dummy lines will not provide a way for making

transmission measurements because the dummy lines are not representative of actual lines in regard to electrical characteristics. They will, however, permit communication between the two repeaters using teletypewriters or the manual telegraph sets and will provide a way of checking the settings of the LINE switch. Local options, other than teletypewriter option, may be checked by resistance or voltage drop measurements on continuity of wiring, using the voltohmmeter.

Caution: Do not touch terminals with hands as high voltages are present. Do not allow one test pick to touch two metal parts at the same time because dangerous short circuits may occur. The procedures described in the point-to-point voltage and resistance measurement chart are intended as a guide for making point-to-point voltage measurements. Typical test values are not absolute and are provided only as a basis of comparison with the voltage or resistance measurement found when testing the individual items of apparatus. When making point-to-point voltage tests in a series circuit, consideration must be given to a possible ±15 percent allowable variation in resistance connected in the circuit with the apparatus under test.

80. Repairman's Trouble-Locating Chart

Symptom	Probable trouble	Correction
No line current with LINE switch in position 1 or position 3.	Trouble in ADJ LINE CURRENT switch or potentiometer.	Repair or replace switch or potentiometer.
Errors on printed copy on incoming signals with teletypewriter connected directly to Repeater TG–30.	Poor jack or plug contacts on teletypewriter cords.	Repair or replace jack or plug.
Errors on printed copy when sending locally with teletypewriter connected directly to Repeater TG–30.	Poor jack or plug contacts on teletypewriter cords.	Repair or replace jacks or plugs.
No d-c voltage output.	Poor contact in AC-DC power switch or 115V–230V switch.	Repair or replace switches.
	Fuse D blown because of short-circuited electrolytic capacitors C1 or C2.	Replace short-circuited capacitors and fuse.
	Open wiring in transformers T1 or T2 or in retardation coil L1.	Replace transformer or retardation coil.
Low d-c voltage output.	Varistor A in power unit defective.	Replace varistor A. This varistor should be replaced soon after it becomes necessary to set the ADJ VOLTS switch at the maximum INCREASE position to obtain a 115V d-c output with 115V a-c input.
High d-c output voltage.	Resistor R in power unit may be open. (High voltage will appear at light or no-load only.)	Repair wiring to resistor or replace defective resistor.
Erratic d-c output voltage.	Electrolytic capacitor C1 or C2 defective.	Replace capacitors.

81. Point-to-Point Voltage and Resistance Measurement Chart

Purpose of test	Preparation	Part tested and reading
1. To check resistance of winding of polar relay.	Remove relay from repeater. Viewing relay from the terminal pin side, as shown in figure 8, the terminal just to the right of top center will be terminal 1. The terminals are numbered consecutively from this point in a clockwise direction.	*Windings* — *Resistance values* 3–6 — 90 ±9 ohms 2–7 — 1,450 ±145 ohms 8–9 — 1,450 ±145 ohms Check all terminals for ground to relay framework. No terminals should be grounded and each should indicate infinite resistance to the framework.
2. To check voltage drops in rectifier power unit under marking load of 300 milliamperes.	Connect teletypewriter and turn LOCAL switch to position 1. Turn LINE switch to position 1. Connect a 500-ohm resistor externally between LINE 1 binding post and GND binding post and connect GND binding post to ground. Connect power cord to 115 volts ac, 50-60-cycle power supply. Adjust voltage to 115 volts and adjust line current to 18 milliamperes.	*Voltage drop across* — *A-c voltage measurements* Midpoint of transformer T1 to common terminal C. — 113-volts Total winding of transformer T1. — 225-volts Primary winding of transformer T2. — 211-volts Secondary winding of transformer T2. — 197-volts A-c input terminals of varistor A. — 148-volts *D-c voltage measurements* + and — Terminals of varistor A. — 117-volts Retardation coil L1. — 2-volts + and — output terminals of rectifier power unit. — 115-volts
3. To check value of series resistors associated with ADJ LINE CURRENT knobs COARSE and FINE.	Repeater arranged as in item 2 except COARSE knob in extreme counterclockwise position and FINE knob in maximum increase position.	Repeater TG–30 meter should read 22 milliamperes.
	Turn FINE knob slowly counterclockwise.	Current should fall smoothly to 16 milliamperes.
	Turn COARSE knob one step in INCREASE direction.	Current should rise to 21 milliamperes.
	Turn COARSE knob one more step in INCREASE direction.	Current should rise to 26.5 milliamperes.
	Turn COARSE knob one more step in INCREASE direction.	Current should rise to 38 milliamperes.
4. To check retardation coil A and certain resistors.	Repeater marking and arranged as in item 2.	*Voltage drop across* — *D-c voltage measurements* Retardation Coil A — 0.8-volts Resistor AB — 75-volts Resistor AA — 40-volts Resistor E — 75-volts Resistor M — 48-volts Resistor N — 48-volts Resistor AE — 42-volts Resistor AF — 55-volts Resistor T — 107-volts Resistor P — 35-volts Resistor R — 23-volts Resistor S — 38-volts

81. Point-to-Point Voltage and Resistance Measurement Chart (Continued)

Purpose of test	Preparation	Part tested and reading	
5. To check resistors K and Z and varistor A.	Repeater arranged as in item 2. Increase current to about 45 milliamperes by turning ADJ LINE CURRENT knobs. This increases the line current so that it overrides the marking bias of the receiving relay and operates it to spacing.	Resistor K (1,200-ohm section) Resistor K (1,600-ohm section) Resistor Z Varistor A (Terminal 1 to terminal 3)	42-volts 32-volts 46-volts 9.3-volts
6. To check resistors H and L.	Turn LOCAL switch to position 2. Connect LOCAL 1 binding post to an adjustable resistance box in series with a milliammeter to negative 115 volts and adjust current to 60 milliamperes. (Note: Line Unit BE–77–A may be used.) Repeater arranged as in item 2 except teletypewriter cords removed.	Resistor H Resistor L	36-volts 30-volts
7. To check resistors W and J.	Turn LOCAL switch to position 5. Connect an adjustable resistance box in series with a milliammeter between LOCAL 1 and LOCAL 2 binding posts and adjust the current to 30 milliamperes. Repeater arranged as in item 2 except teletypewriter cords removed.	Resistor W Resistor J	22-volts 4.5-volts
8. To check 16-microfarad capacitor E.	Repeater arranged as in item 7. Remove relay R. Connect meter (150-volt scale) to terminals of capacitor.	Meter should read about 70 volts.	
	Remove relays S1 and S2.	Meter indication should gradually fall to zero.	
9. To check spark-killer capacitor and resistors.	Use the voltohmmeter as an ohmmeter. Remove relays R, S1 and S2, and do not have power cord connected.	Resistors X, V, and AD should indicate a resistance of 3,200 ohms total (1,600 ohms each side of center tap). Resistor AC should indicate 1,600 ohms. Capacitors D, F, G, H, K, J, and L should indicate infinite resistance terminal-to-terminal and both terminals to the framework.	

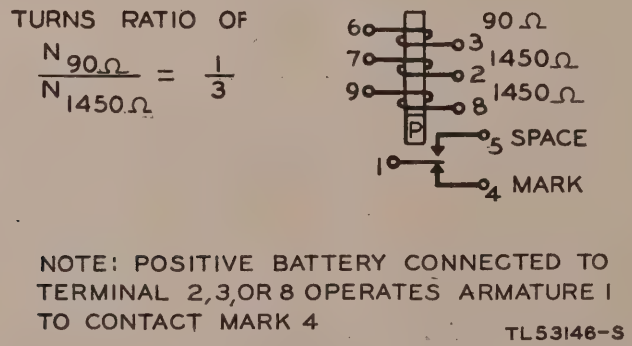


Figure 51. Winding and terminal arrangements of polar relay.

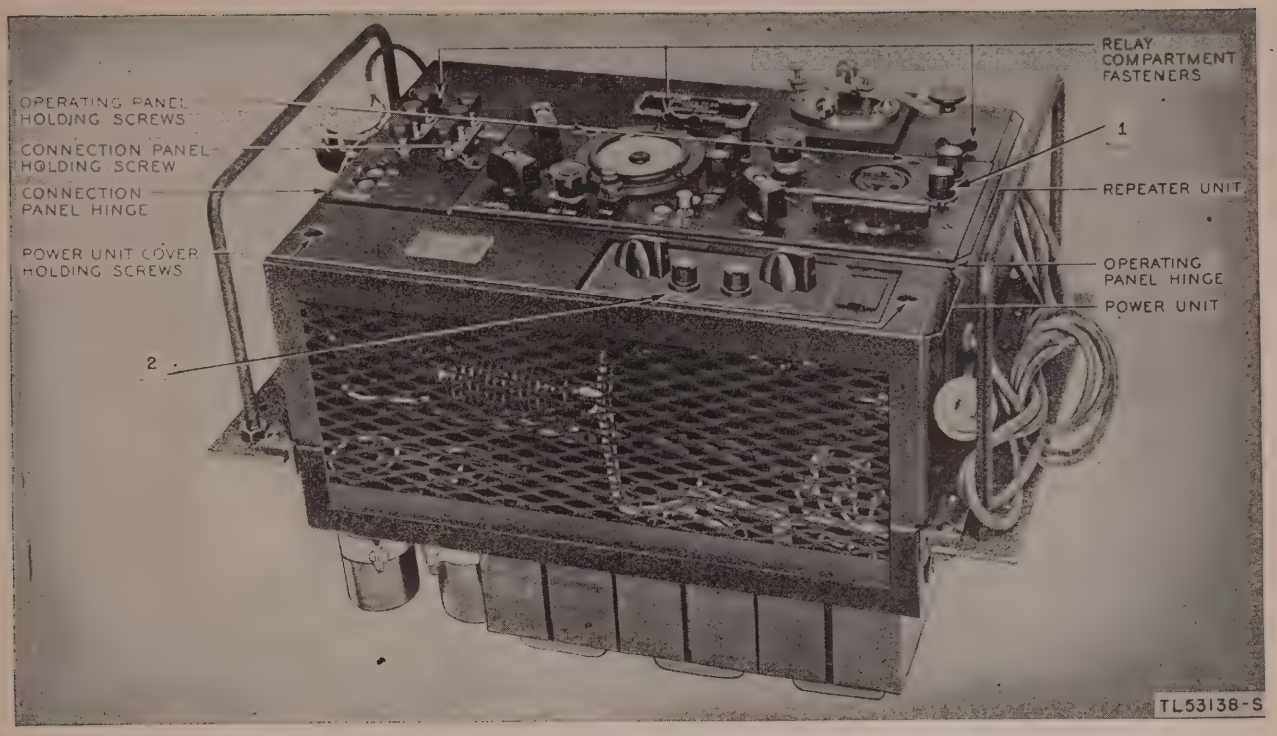


Figure 52. Repeater TG–30 (Terminal, Telegraph), removed from carrying case, front view.

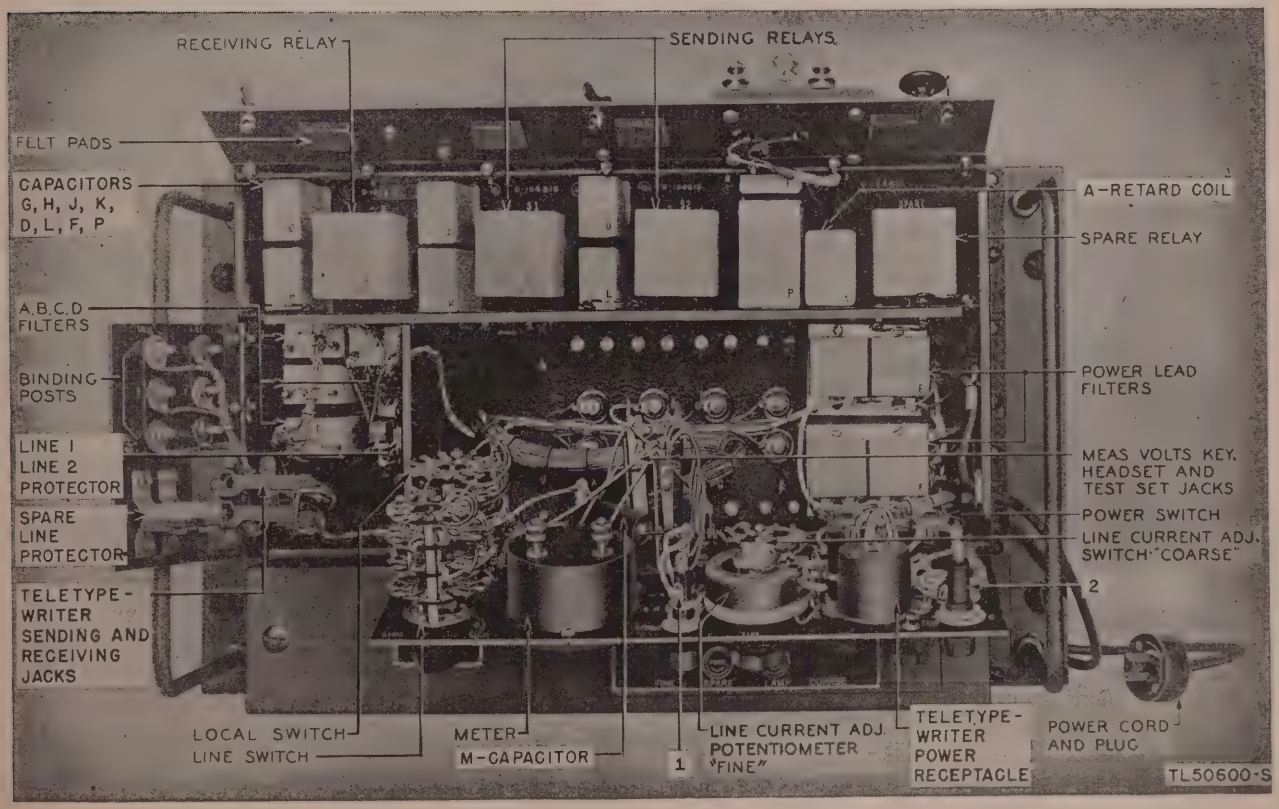


Figure 53. Repeater TG–30 (Terminal, Telegraph), top panels open.

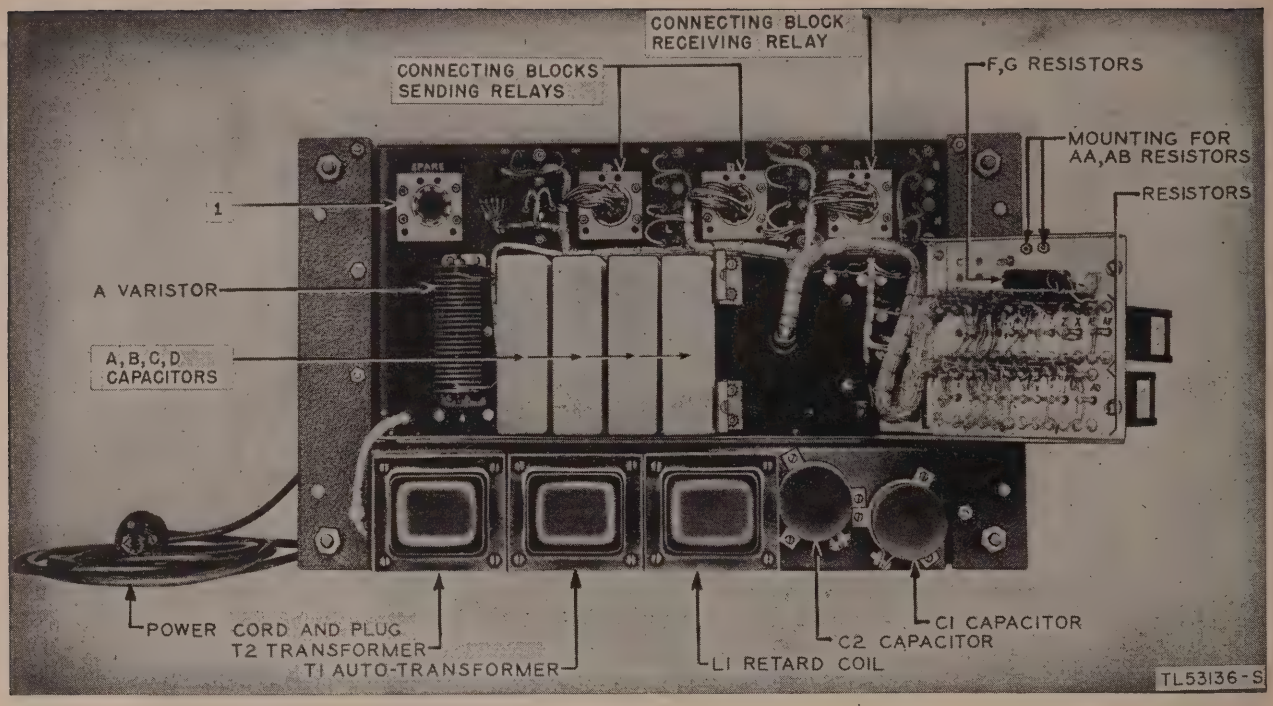


Figure 54. Repeater TG–30 (Terminal, Telegraph), rear view, resistor panel open.

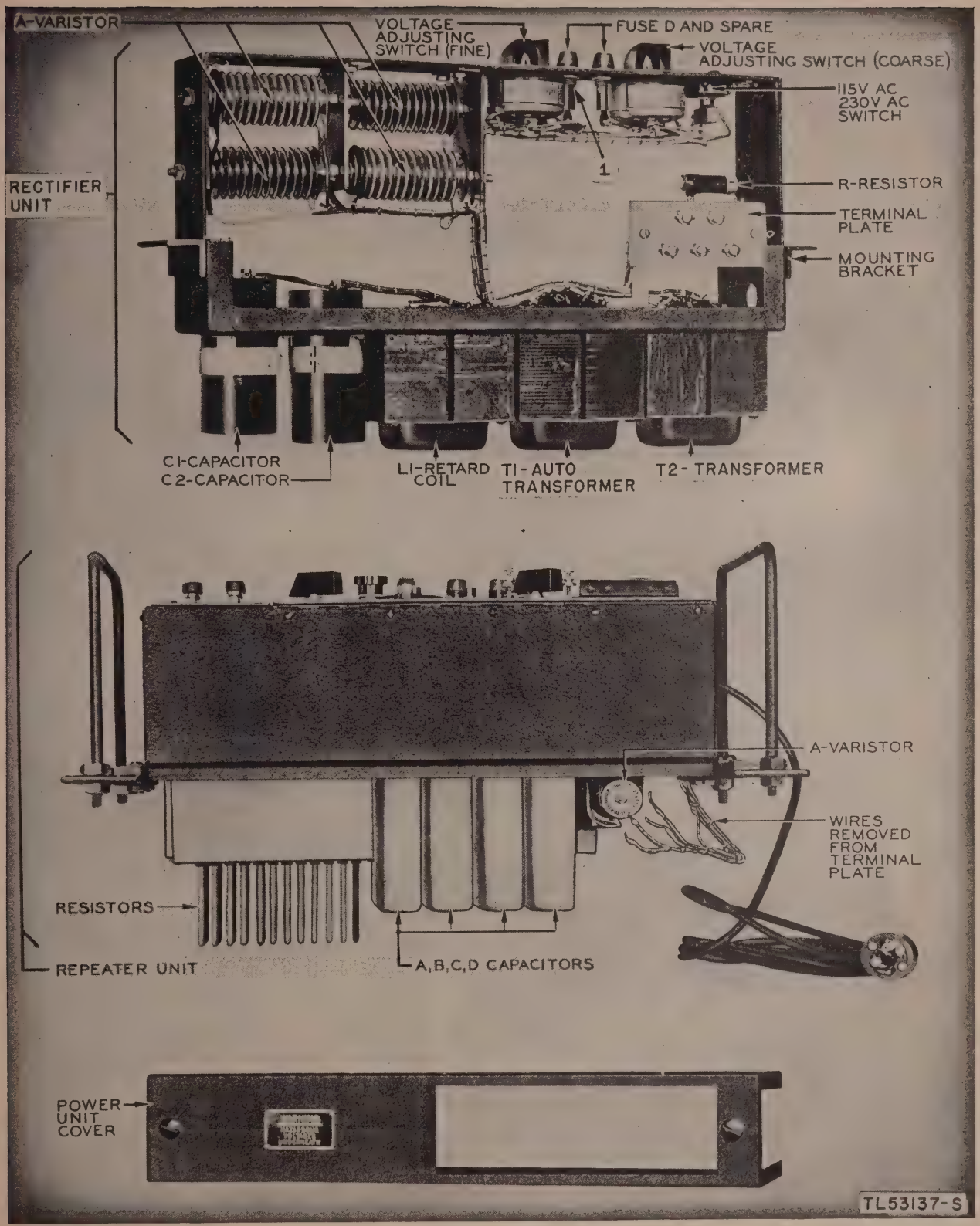


Figure 55. Repeater TG–30 (Terminal, Telegraph), power unit removed from repeater unit.

Section XVI. REPAIRS

82. Disassembly for Repairs

a. REMOVING UNIT FROM CARRYING CASE. Disconnect all wires and cords. Loosen the four large roundhead assembly screws designated in figure 5. These screws hold the basic framework of the equipment to the carrying case brackets. Lift the unit from the carrying case, using the side handles, and place it on a bench, or other suitable support, for testing.

b. REMOVING RECTIFIER POWER UNIT FROM REPEATER UNIT. If necessary, the rectifier power unit can be removed from the repeater unit after the unit is removed from the carrying case. Loosen the two fasteners holding the rectifier power unit cover in place and remove the cover. (See fig. 52.) Disconnect the five wires attached to the power-unit terminal plate. (See fig. 55.) Remove the two roundhead holding screws on each side bracket which mounts the power unit to the framework. The power unit may now be removed from the framework. When replacing these wires refer to color codes shown in wiring of circuit. (See fig. 59.)

83. Replacement of Parts

a. Most of the parts in Repeater TG–30 are readily accessible and may be easily replaced if they are found to be faulty.

b. The fuses and neon lamp may be replaced without removing the repeater from the carrying case.

c. To replace defective parts in the rectifier power unit, the unit may be removed from the repeater unit as directed in paragraph 82*b*.

d. When replacing of any part requires the disconnection of several wires, mark the wires with tags or other identifying devices to insure their proper connection when the new part is installed.

e. When replacing leads, clip them as short as possible for satisfactory connection and avoid using more solder than necessary to make a secure connection. A very slight amount of excess solder dropped accidentally inside the equipment may cause other circuits or circuit elements to be short-circuited. Do not heat the lug or connection more than is absolutely necessary to make a well-soldered connection. Excess heat may damage capacitors, resistors, and wiring. When a wire is connected to a relay socket, the connection should be long enough to prevent any pull on the socket. Save time and trouble by making a thorough electrical check of any part that appears to be defective *before* removing it from the equipment.

f. When replacing parts in the equipment use care in disassembly and reassembly. Use screw drivers and other tools that fit the job at hand. Secure bolts and screws snugly, but do not overtighten them.

g. To install gas adsorber units in the relays, follow the self-explanatory photograph included in the assembly envelope. Place one unit on each side of the relay frame, clip the fastening clamps in place over the frame edges, and replace the relay cover. On new equipment, gas adsorber units are installed on each relay in use and one set of spare gas adsorber assemblies are furnished for each relay. For equipment which does not contain gas adsorber units, the assemblies may be requisitioned from depot stock as "Gas Adsorber Assembly, Signal Corps stock No. 6Z60." The assembly consists of two metal wire cloth bags each containing 2 grams of charcoal, two fastening clamps, and one instructive photograph.

84. Restoration of Electrolytic Capacitors

Electrolytic capacitors C1 and C2 in the rectifier may lose their film if the equipment is held in storage or if it is operated on a d-c supply for a period of 18 months or longer. Replace these capacitors after 3½ years from date stamped on the case whether or not the equipment is in service. Normal operation on a-c power will maintain the capacitors in proper operating condition. To restore the film, connect the power cord of the repeater to an a-c supply for at least 30 minutes every 18 months. If an a-c supply is not available, a source of 96 to 120 volts d-c with a 110/120-volt lamp (25 to 100 watts) in series may be connected to the positive and negative terminals of the power unit for at least 30 minutes every 18 months. Connect the positive side of this lamp circuit to the + DC terminal and the negative side to the — DC terminal on the power unit terminal block. To make a connection to these terminals, remove the power unit cover. (See figs. 52 and 55.)

85. Painting and Refinishing

When a touch-up job is necessary, apply paint with a small brush. When numerous scars and

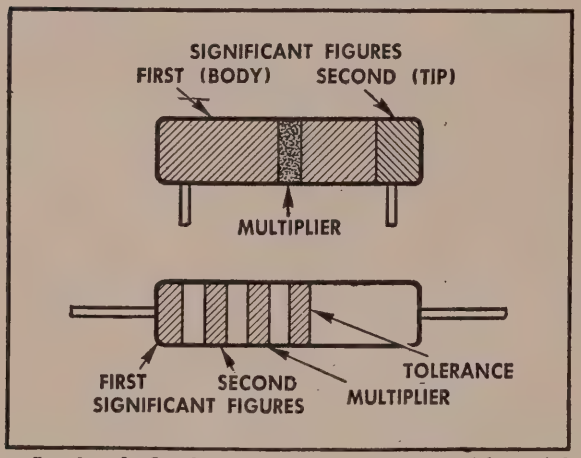
scratches warrant complete repainting, remove the repeater from the carrying case and spray paint over the entire case. Remove rust from the hinges and catches by cleaning corroded metal with dry-cleaning solvent. In severe cases it may be necessary to use dry-cleaning solvent to soften the rust on metal parts, and then use sandpaper to complete the preparation for painting.

Caution: The use of steel wool, although permitting rapid removal of rust, is not recommended. Minute particles of steel wool frequently enter the case and cause harmful internal shorting or grounding of circuits.

Paint used will be authorized and consistent with existing regulations.

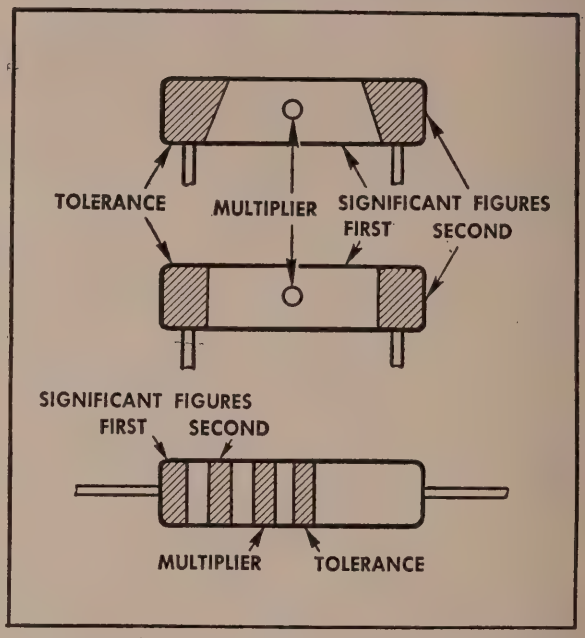
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS



Insulated fixed composition resistors with axial leads are designated by a natural tan background color. Non-insulated fixed composition resistors with axial leads are designated by a black background color.

AWS COLOR CODE FOR FIXED COMPOSITION RESISTORS



The exterior body color of insulated resistors may be any color except black. The usual color is natural tan. The exterior body color of uninsulated resistors with axial leads may be either black or white. The exterior body color of uninsulated resistors with radial leads may be black or it may be the color of the first significant figure of the resistance value.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000	
GRAY	8	100,000,000	
WHITE	9	1,000,000,000	
GOLD		0.1	5
SILVER		0.01	10
NO COLOR			20

RMA: *Radio Manufacturers Association*
AWS: *American War Standard (American Standards Association)*

TL 13418

Figure 56. Resistor Color codes.

APPENDIX I

LIST OF COMPONENT PARTS OF REPEATER TG–30

86. List of Component Parts of Repeater TG–30

Quan	Component
1	Telegraph Repeater TG–30
*1(3)	Fuse FU–26 (1 amp)
2	TM 11–2004
2(2)	Block, protector carbon
2(2)	Block, protector
2(6)	Fuse, ½ amp 250 v
1(3)	Fuse, 5 amp 25 v
1(3)	Lamp, neon LF 5122
3(1)	Relay swbd 3 windings
4(4)	Gas adsorber assembly

*Quantity shown in parentheses are running spares.

Note. This list is for general information only. See appropriate publications for information pertaining to requisition of spare parts.

APPENDIX II

MAINTENANCE PARTS FOR REPEATER SET TC–18

87. Maintenance Parts for Repeater Set TC–18

The following information was compiled on 6 March 1945. The appropriate pamphlets of the ASF Signal Supply Catalog for Repeater Set TC–18 are:

Organizational Spare Parts:
SIG 7–TC–18

Higher Echelon Spare Parts:
SIG 8–TC–18

Fixed Plant Maintenance List:
SIG 10–841.5 Repeater TC–30 and Repeater TC–31.

For an index of available catalog pamphlets, see the latest issue of ASF Signal Supply Catalog SIG 2.

Note. This list covers first, second, and third echelon maintenance parts.

Ref symbol	Signal Corps stock No.	Name
Fig. 2	3Z330–148	Ground rod.
Fig. 52 (1)	3Z930	Fuse cap.
Fig. 52 (2)	3Z930–2	Fuse cap.
Fig. 53 (1)	3Z3285–3	Fuse mounting.
Fig. 53 (2)	3Z1939.1	Fuse mounting.
Fig. 54 (1)	4E400	Connecting block.
Fig. 55 (1)	3Z3285–2	Fuse mounting.
Fig. 57 (7)	4C9156	Relay.
A, B (fig. 57 (4))	3Z2595.6	Fuse.
C (fig. 57 (5))	3Z2605.8	Fuse.
D (fig. 57 (3))	3Z1926	Fuse.
LINE 1 & 2 (fig. 57 (1))	4E926	Block, protector.
LINE 1 & 2 (fig. 57 (2))	4E927	Block, protector.
TONE (fig. 57 (6))	2Z5888	Lamp, neon.

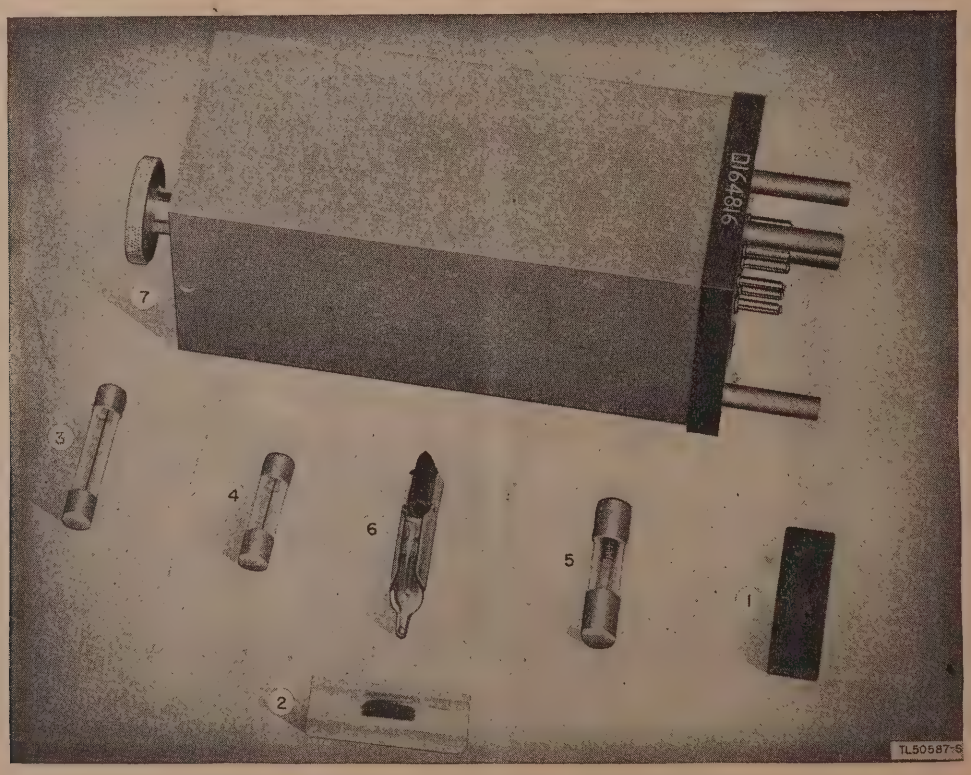


Figure 57. Maintenance parts for Repeater Set TC–18.

APPENDIX III

REFERENCES

88. Parts List

SIG 1, Signal Supply Catalog, Introduction.
SIG 2, Signal Supply Catalog, Index.
SIG 3, List of Items for Troop Issue.
SIG 4–1, Allowances of Expendable Supplies.
SIG 4–2, Allowances of Expendable supplies for Schools, Training Centers, and Boards.
SIG 5, Stock List of All Items.
SIG 6, Sets and P & I Control List.
SIG 7, Organizational Spare Parts.
SIG 8, Higher Echelon Spare Parts.
SIG 10, Fixed Plant.

89. Technical Manuals of Auxiliary Equipment and Test Equipment

TM 11–352, Printers TG–7–A, TG–7–B, and TG–37–B; Chests CH–50–A and CH–50–B; Chests CH–62–A and CH–62–B.
TM 11–355, Telegraph Terminal CF–2–A (Carrier).
TM 11–355B, Telegraph Terminal CF–2–B (Carrier).
TM 11–358, Telegraph Central Office Set TC–3.
TM 11–359, Line Units BE–77, BE–77–A, and BE–77–B.
TM 11–755, Grounds, Grounding Procedure, and Protective Devices for Wire Communication Equipment.
TM 11–2005, Repeater Set TC–19 (Intermediate).
TM 11–2009, Telegraph Terminal CF–6 (Carrier).
TM 11–2029, Voice-Frequency Carrier Telegraph Packaged Equipment.
TM 11–2032, D-C Regenerative Telegraph Repeater (Packaged Equipment).
TM 11–2034, D-C Telegraph Repeater Packaged Equipment.
TM 11–2206, Telegraph Terminal Set AN/TCC–1, Telegraph Terminal TH–1/TTC–1 and Filter F–2/GG.
TM 11–2513, Test Set I–193–A.
TM 11–2613, Voltohmmeter I–166.

90. Painting, Preserving, and Lubricating

TB SIG 123, Preventive Maintenance Practices for Ground Signal Equipment.

91. Shipping Instructions

U.S. Army Spec No. 100–14A, Army-Navy General Specifications for Packaging and Packing for Overseas Shipment.

92. Decontamination

TM 3–220, Decontamination.

93. Camouflage

FM 5–20, Camouflage, Basic Principles.

94. Other Technical Publications

FM 21–6, List of Publications for Training.
FM 21–7, List of War Department Films, Film Strips, and Recognition Film Slides.
FM 21–8, Military Training Aids.
FM 21–40, Defense Against Chemical Attack.
TB SIG 13, Moistpreproofing and Fungiproofing Signal Corps Equipment.
TB SIG 25, Preventive Maintenance of Power Cords.
TB SIG 66, Winter Maintenance of Signal Equipment.

TB SIG 69, Lubrication of Ground Signal Equipment.
TB SIG 72, Tropical Maintenance of Ground Signal Equipment.
TB SIG 75, Desert Maintenance of Ground Signal Equipment.
TB SIG 172, Gas adsorber units for polar relays (Weco types 255–A, D–164816, D–163119–A, and D–168651).
TM 1–455, Electrical Fundamentals.
TM 11–462, Signal Corps Reference Data.
TM 37–250, Basic Maintenance Manual.

95. Forms

WD AGO Form 468, Unsatisfactory Equipment Report.
AAF Form 54, Unsatisfactory Report.

96. Abbreviations

AAF, Army Air Forces.
a-c, Alternating-current (adj).
ac, Alternating current (noun).
AGO, Adjutant General's Office.
ASF, Army Service Forces.
cap., Capacitor.
d-c, Direct-current (adj).
dc, Direct current (noun).
dx, Duplex.
fig., figure.
fil, filter.
mf, microfarad.
mtg, mounting.
No., Number.
par., paragraph.
pot., potentiometer.
prot, protector.
rcv, receive.
regen, regenerative.
ry, relay.
res, resistor.
spec, specification.
subpar., subparagraph.
term. st, terminal strip.
v, volt(s).
WD, War Department.

97. Glossary

The following glossary contains information in explanation of technical terms used in this manual.

Battery. The term battery is normally used when referring to a group of dry cells or storage cells. In telegraph communication, it is common usage to refer to any d-c source used in production of telegraph signals as "battery." Consequently, this manual applies the term to the dc supplied by the rectifier.

Full-duplex. A telegraph circuit arranged for full-duplex operation uses independent paths for the two directions of transmission making it possible to send and receive simultaneously in both directions.

Half-duplex. A telegraph circuit arranged for half-duplex operation uses only one path for the two directions of transmission; therefore, it is possible to send or receive in only one direction at a time.

Mark. In neutral operation, the closed circuit signal is referred to as a mark, and the open circuit signal is known as a space. In polar operation, the marking and spacing nomenclature is retained but it refers to the direction of current flow rather than to the open and close condition as in neutral operation.

Neutral operation. Where marking signals are formed by current pulses of one polarity either positive or negative, and spacing signals are formed by reducing the current to zero or nearly zero.

Neutral relay. A relay which operates in exactly the same way, regardless of the direction in which current flows through its windings.

Polar operation. A type of telegraph transmission in which marking signals are formed by current pulses of one polarity and spacing signals by current pulses of equal magnitude but of opposite polarity.

Polarential Operation. A type of telegraph transmission in which signals are sent in one direction by reversing polarity of current and in the other by varying the magnitude of the current.

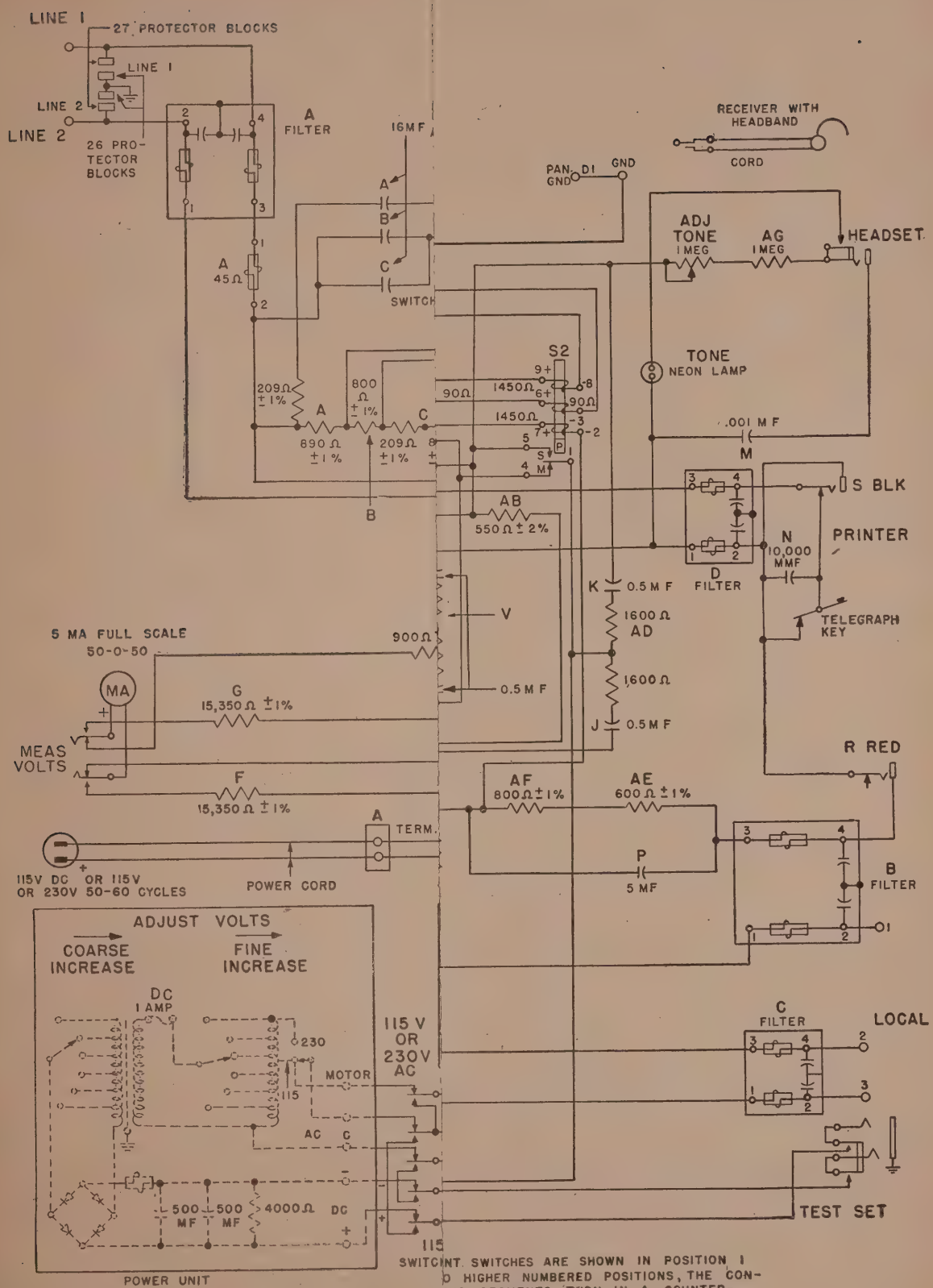
Polar relay. A relay, the armature of which is pulled to one contact when current flows in one direction through its windings, and to the other contact when current is reversed in direction.

Space. See mark.

Station. A teletypewriter and its associated equipment.

Two-path polar operation. A method of operation which requires two line circuits and uses polar operation on both the sending and receiving ends of the line.

Varistor. A dry-disk rectifier such as a selenium or copper-oxide rectifier.



SWITCH. SWITCHES ARE SHOWN IN POSITION 1
O HIGHER NUMBERED POSITIONS, THE CON-
ING SEGMENTS TURN IN A COUNTER-

TL 53140-8

TB SIG 69, Lubrication of Ground Signal Equipment.
TB SIG 72, Tropical Maintenance of Ground Signal Equipment.
TB SIG 75, Desert Maintenance of Ground Signal Equipment.
TB SIG 172, Gas adsorber units for polar relays (Weco types 255–A, D–164816, D–163119–A, and D–168651).
TM 1–455, Electrical Fundamentals.
TM 11–462, Signal Corps Reference Data.
TM 37–250, Basic Maintenance Manual.

95. Forms

WD AGO Form 468, Unsatisfactory Equipment Report.
AAF Form 54, Unsatisfactory Report.

96. Abbreviations

AAF, Army Air Forces.
a-c, Alternating-current (adj).
ac, Alternating current (noun).
AGO, Adjutant General's Office.
ASF, Army Service Forces.
cap., Capacitor.
d-c, Direct-current (adj).
dc, Direct current (noun).
dx, Duplex.
fig., figure.
fil, filter.
mf, microfarad.
mtg, mounting.
No., Number.
par., paragraph.
pot., potentiometer.
prot, protector.
rcv, receive.
regen, regenerative.
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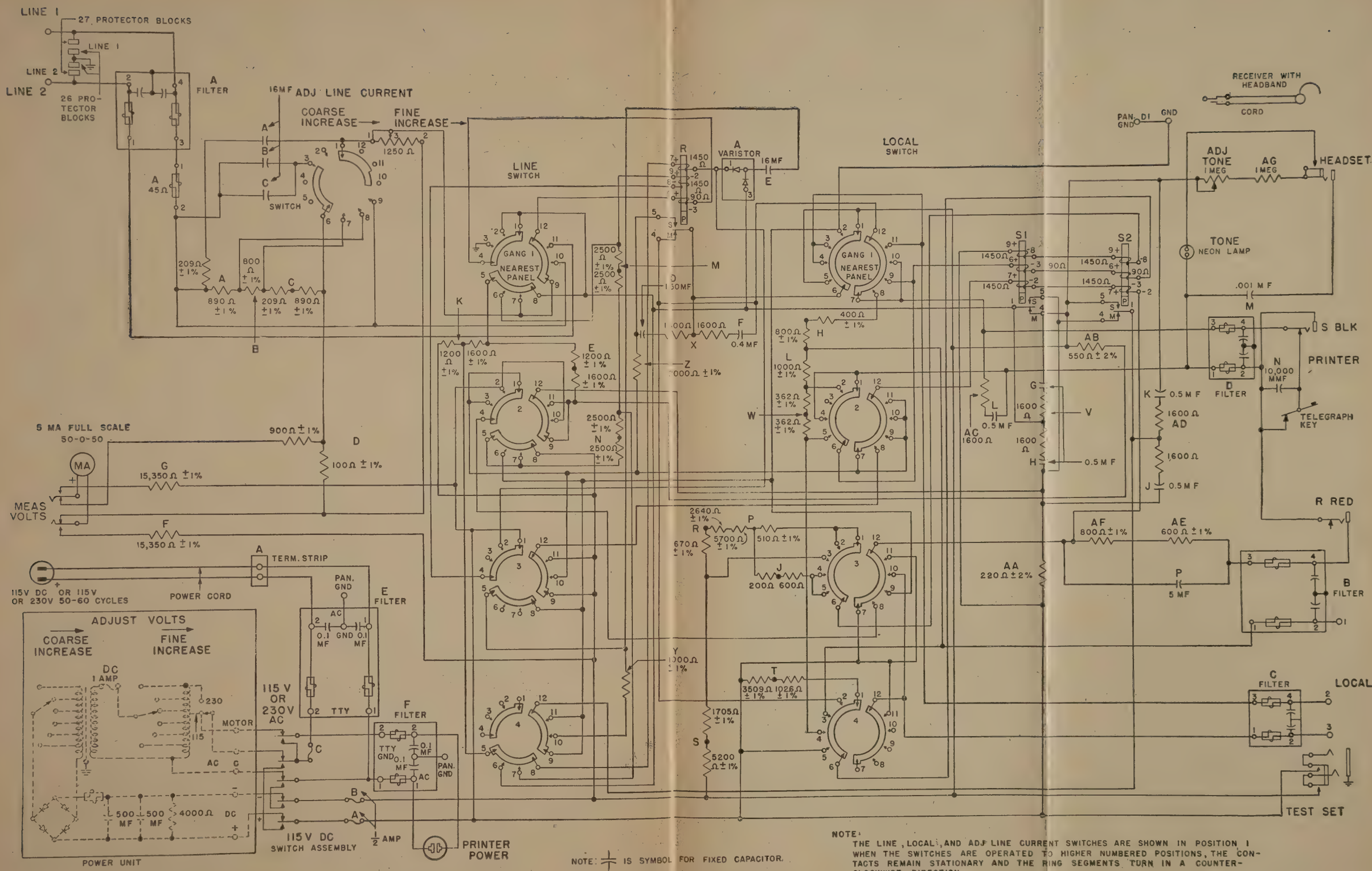


NOTE: ⊣⊢ IS SYMBOL FOR FIXED CAPACITOR.

NOTE:
THE LINE, LOCAL, AND ADJ LINE CURRENT SWITCHES ARE SHOWN IN POSITION 1 WHEN THE SWITCHES ARE OPERATED TO HIGHER NUMBERED POSITIONS, THE CONTACTS REMAIN STATIONARY AND THE RING SEGMENTS TURN IN A COUNTER-CLOCKWISE DIRECTION.

TL 53140-S

Figure 58. Schematic, repeater circuit.

FIG. 1

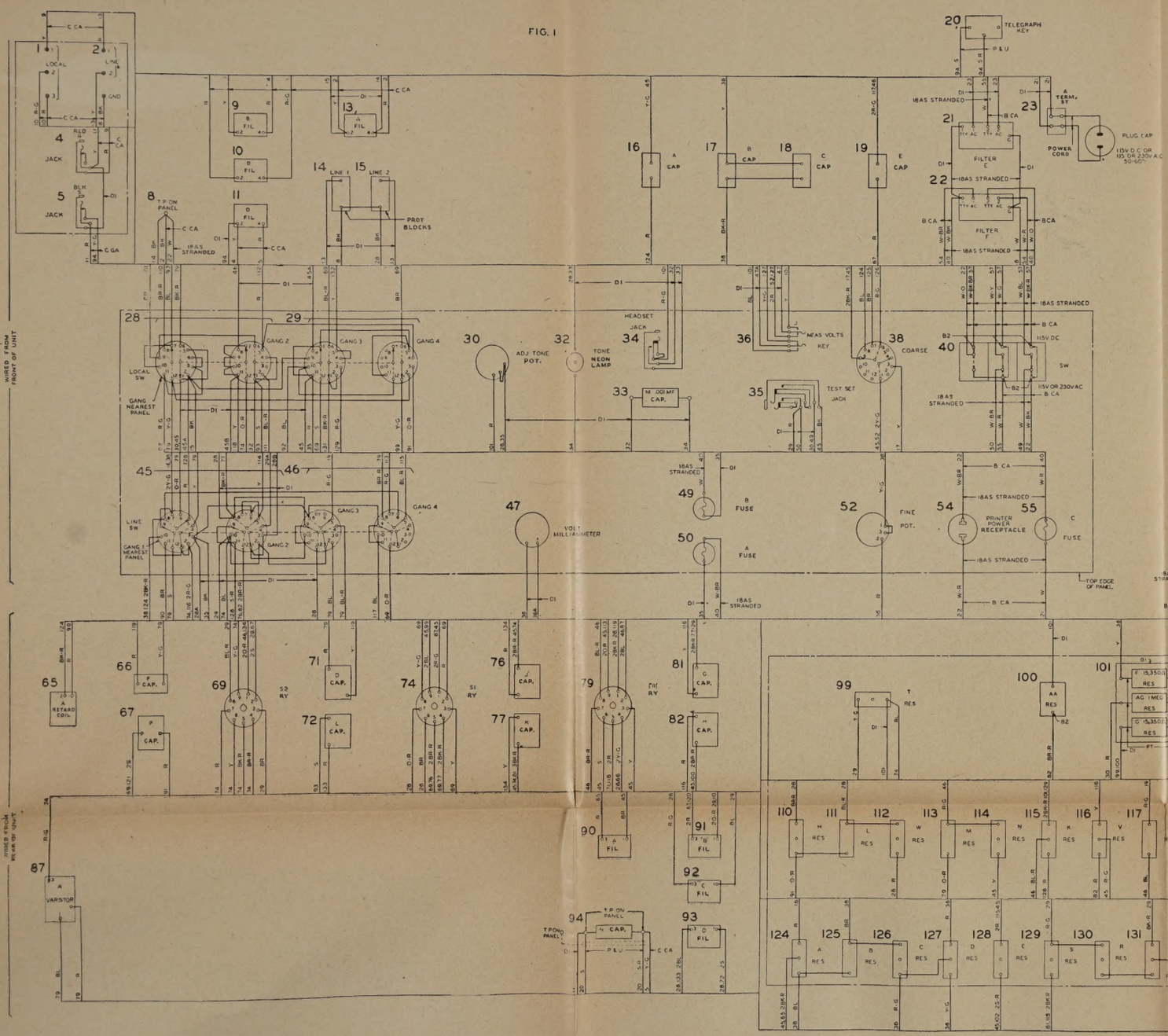
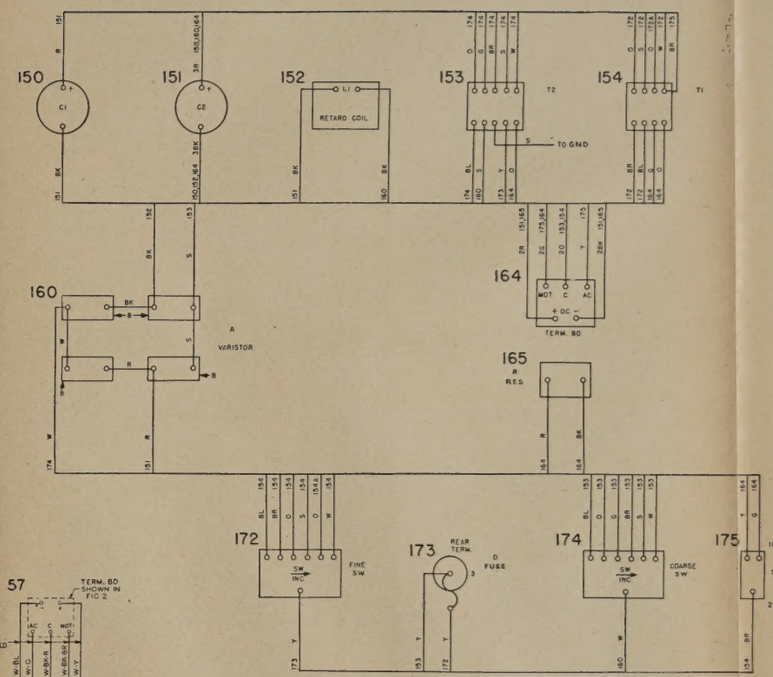


Figure 59. Wiring of circuits, circuit label.

FIG. 2
SEE NOTE 8



NOTE:
1. ALL WIRING IS 22AW UNLESS OTHERWISE SPECIFIED
2. "D" WIRING IS 6 22AW WIRE, RUN DIRECTLY FROM TERMINAL TO TERMINAL INDEPENDENTLY OF ALL OTHER LEADS, WITH 1/2 INCH SLACK IN EACH LEAD
3. "R" EDGE OF RES MTG NEAREST PANEL
4. "82" TERM NEAREST PANEL
5. WIRES IN REPEATER UNIT NOT OTHERWISE SPECIFIED RUN IN "A" CABLE
6. "PT" DENOTES LEADS FURNISHED AS PART OF APPARATUS
7. "J" END OF KEY NEARER HINGE LOOKING AT TERM SIDE
8. WIRED BY MANUFACTURED PER KS-5825, FIG. 2 USING 18 GA STRANDED NOFLAME-COR WIRE (CORNISH WIRE CO. INC.)
9. LEADS DESIGNATED "U" SHALL BE 22P WIRE
10. "P" DENOTES PAIR
11. ⊂⊃ DENOTES SHIELD CONNECTION
12. "B" DENOTES NAMEPLATE END OF VARISTOR

TL 53141-S

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